the review of POPULAR ASTRONOMY

FORMERLY . . . THE MONTHLY EVENING SKY MAP

IN THIS ISSUE:

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★ The Vanishing Sky!

★ Through the Three-Inch

★ Outer Space Photography

★ New Monthly Sky Maps

★ Your Telescope and Mine

★ $25 Telescope Mounting

VOL. LV NO. 512

FIFTY CENTS

AUGUST 1961

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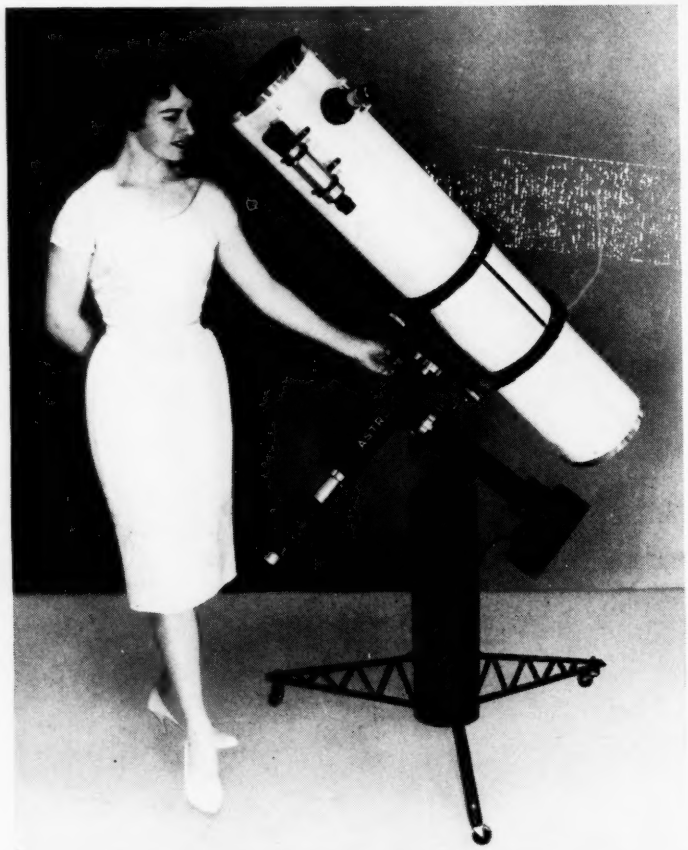

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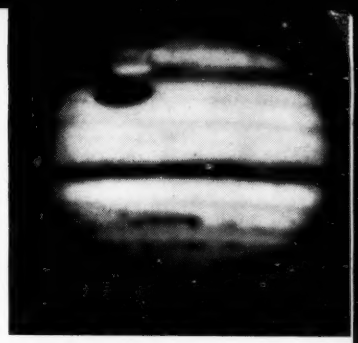

JULY-AUGUST 1961
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THE REVIEW OF POPULAR ASTRONOMY

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COVER PHOTO

One of Jupiter's satellites approaches transit across the giant planet's disk. The great red spot is prominent in this excellent photograph made with the 200-inch reflector at Mount Palomar. (Courtesy of Mt. Wilson-Mt. Palomar Observatories.)

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THE AMATEUR'S FORUM

Dear Sirs:

I have read that a certain moon of Saturn — Japetus — is variable. I would like to know the reason for this. If you can help me, I would appreciate it.

Alan Smith, Jr.
Versailles, Ind.

Japetus varies from approximately 9.5 to 11.0, depending upon the direction of its elongation, or farthest apparent distance east or west of the planet. Even in the glare of the planet, Japetus is visible in a 3-inch at western elongation. You might check it this summer, first on July 21st at the bright western elongation, then on Aug. 29th at the usually fainter eastern elongation. The satellite quite possibly has the same rotation and revolution periods, with a surface which reflects light more efficiently from one hemisphere than from the other.

The Editors:

The red shift is commonly taken as an indication that distant objects in the heavens are receding from us. This Doppler effect, if it be such, is proportional to the distance from us, giving rise to the exploding universe theory. Not explained is why other spectral colors are not similarly affected. Why should the Doppler shift be selective for the red only?

Point Pleasant, N. J.
Page Stelle

As applied to stellar spectroscopy, the red shift actually indicates the displacement of the spectral lines toward the red end *of the spectrum, not a selective shift of the red segment of the spectrum itself. A star which is approaching, according to the Doppler-Fizeau effect, will show its spectral lines shifted* away *from the red end of the spectrum. The amount of this shift only indicates velocity, not distance, which is merely inferred from velocity and other considerations in the case of distant objects.*

Dear Sirs:

Your heliocentric charts are terrific! I have been looking for such a thing in vain for many years and the placement of the perihelion and aphelion points relative to ours, to say nothing of the ascending and descending nodes. This requires a lot of work when transferring the figures to a chart. I plan on photographing them each month and blowing them up to 11 x 14 inches. How anyone could possibly complain about their inclusion is completely beyond my comprehension.

Sherman W. Schultz, Jr.
Cobb Road Observatory
944 Cobb Road
St. Paul 12, Minn.

We're happy to hear from you and other readers that these charts are being used. Of course, plotting the orbits of the planets to scale does not allow us to put the entire solar system on one chart, but we feel that the new system is a considerable improvement, for it shows the planets in their proper relationships—conjunctions, oppositions, quadratures, elongations, etc. Detailed explanation for their full use is given in the March-April 1961 issue of RPA.

Dear Sirs:

I am writing to you about my observation of a solar flare, a very unusual occurrence since I have no special solar-study instruments. The flare observed was seen through a 3-inch catadioptric telescope of my own design, coupled with an Edmund solar filter.

The observation was actually an accident, my main purpose in solar observing being to draw the sunspots

(Continued on page 34)

OBSERVING STAR COLORS

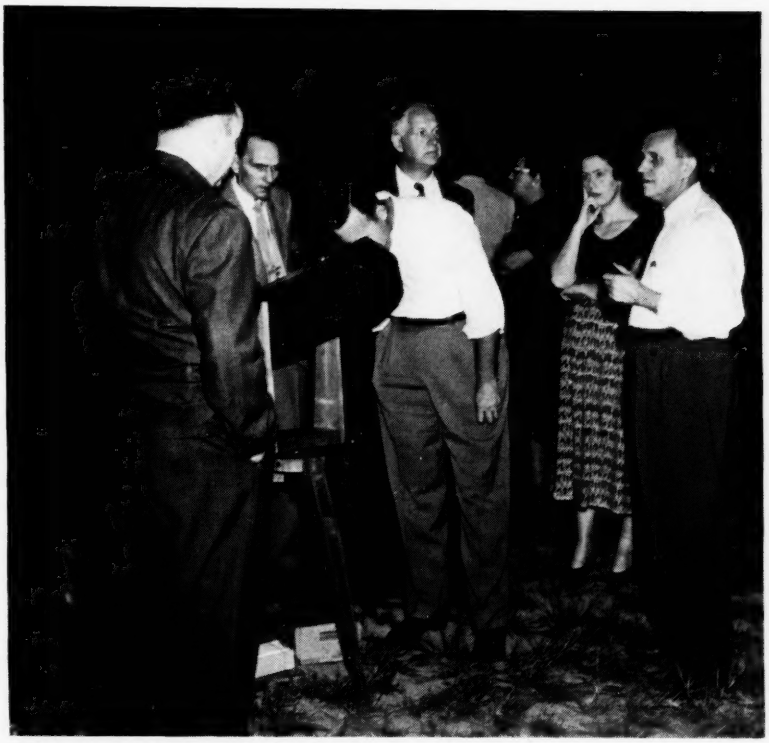
STUART L. O'BYRNE

The author shows how the amateur can train his eye to become conscious of star colors, then points out how he can use this skill to determine interesting facts about the stars directly at the eyepiece of a small telescope. Mr. O'Byrne, several times president of the St. Louis Astronomical Society, has managed over the years to squeeze amazing results from the modest two- and six-inch telescopes he uses. He also prepares the monthly planet data for this magazine and assisted in the preparation of the new heliocentric charts.

THERE IS ABUNDANT EVIDENCE in the astronomical literature over the years that the colors of the stars have attracted the attention of man. Most of the modern references to the colors of stars are in connection with the observation of double stars. The Rev. T. W. Webb, in his *Celestial Objects for Common Telescopes*, besides giving us a long list of colored pairs, mentions a number of single stars with unusual spectra, mostly of Secchi's types III and IV. These are often rather highly colored stars, or stars whose colors were suspected of change since the earlier observers recorded them. Webb tells us that observations of single stars should be valuable in noting possible changes of color in the future. Since modern observatory equipment is capable of recording color differences far more subtle than are distinguished by the human eye, it would appear that visual work would be futile.

A list of the spectral classes with their "mean colors" is quoted in *Norton's Atlas* from the *Monthly Notices* of the Royal Astronomical Society. Norton does not tell us how these were derived, but if done by the actual measurement of the intensities of light in the various wave lengths, they do not reflect accurately their appearance to the eye. If done visually, they only tell us how they looked, on the average, to the observers. Each one of us might see them differently, as will be demonstrated later. There appears to be no way to correlate one observer's color estimates with those of another. Color perception is highly variable among human beings, even in the same individual. An attempt was made during the 1930's by the Star Colour Section of the New Zealand Astronomical Society to standardize color observations of the stars through the use of prepared color scales procured from W. H. Pickering of Jamaica. These were exposed to artificial light at the telescope and the extra-focal images of stars were compared directly with the lighted scales. These efforts were apparently discontinued after several years, however. It would seem that the use of artificial light would create a difficult problem involving the variations in the type of light given by different lamps. Nevertheless, the

Beautiful photograph of the Pleiades, made in red light with the 18-inch Schmidt camera at Mount Palomar. The author shows how, by noting the color of the brighter stars in a cluster, an observer can, when armed with further information on stellar spectra, make some interesting speculations as to the distance of these stellar aggregations.



Group of amateurs at star party observing through wooden-tubed 6-inch f/4 reflector used by Stuart O'Bryne in his color studies. Author is in foreground at right, in white shirt.

New Zealand observers did work toward a determination of color indices by setting up standard stars and making multitudes of visual observations.

Some years ago it occurred to me that it might be interesting to see how closely one could estimate the spectral class of a star by noting its color. The first trials were not very good, as they consisted in trying to match the observed color of the stars with the "color class" corresponding with spectrum as given in the text books. There was some correlation in evidence, but the red stars, in particular, and all stars, to some degree, appeared too blue.

After observing a number of bright stars of known spectral class and comparing them, it was discovered that, to this observer, at least, they were less deeply colored than the descriptions would indicate. This suggested that the best way to attack the problem was to observe closely stars representing all classes, and compare stars of unknown spectrum with them. It was a pleasant surprise when I discovered that, not only could the spectral classes of the stars be estimated, but in most cases the estimates were within half a class of the spectrum shown in the Yale *Catalogue of Bright Stars*, by Frank Schlesinger. From this time onward I was very color-conscious when seeing stars. Now, when at the eye-piece, I unconsciously note the colors of stars that come into the telescopic field. This at once gives me some indication of the intrinsic characteristics of the stars. Always, the color impression is translated directly into spectral type, without much thought as to the actual color shade or tone. This becomes possible after considerable experience with many stars.

To illustrate the accuracy of the method, let us analyze the results of observations of eighteen stars made by the writer some years ago. All the stars were in the constellation Leo, and between 4.0 and 6.3 magnitude. All spectral classes were represented, but the class of each star was unknown to the observer at the time of observation. Estimates were made directly to one-tenth of a class.

Checking with the spectral types shown in Schlesinger's catalogue, it was found that:

Five stars were estimated exactly correct.
Two stars were estimated in error by 0.2 of a class.
Two stars, in error by 0.3 of a class.
Five stars, in error exactly 0.5 of a class.
Three stars, 0.8 in error.
One star exactly 1.0 class in error.

The mean error of all estimates was 0.38 of a class, or just slightly over one-third of a class. The percentage of error was determined as:

Perfect accuracy, 28%.
Within one-third of a class, 50%.
Within one-half of a class, 78%.
Exceeding a full class: none.

A probable error of about one-third of a spectral class is indicated.

Now, let us see what inexperienced observers can do with star colors. A number of years ago, ten persons with no observational experience were shown a sequence of six stars, one each of the six main classes. Immediately afterward they were shown another series without any knowledge of the types. Only two failed to put each star in its correct class or an adjacent one. If novices can do this well, amateur astronomers should do very well indeed.

Star color observations also add zest to the study of the star clusters. A good four- or five-inch refractor, or a six-inch reflector, will show the colors of a few of the brightest stars in some of the nearest clusters. These stars are important as criteria for the classification of clusters. Four principal groups of clusters were recognized by Trumpler, in his classification, with about 95% of them falling into one or the other of two of the types. Trumpler's type 1b, with its brightest stars of class B and progressing down the main sequence as fainter stars are reached, is equivalent to Shapley's Pleiades type; and Trumpler's type 2a, with its brightest stars of classes K, G and A, and down

the main sequence to the fainter stars, is equivalent to Shapley's Hyades type. This suggests, at once, that if colors of the brightest stars of a cluster can be distinguished, we can place the cluster into one of these classes. An observation of the Praesepe cluster by my daughter will illustrate the method.

Jean was looking at the Beehive with her little three-inch reflector, when I asked if she could notice any color in the stars. At first, she was hesitant, and then she did notice some yellow color in three of the brightest stars, but no color, she insisted, was apparent in the very brightest. She drew a diagram showing the relative positions of the four stars and marked which were yellow. Checking later with the catalogue, which includes only three of the cluster stars, we found that the spectra, in order of brightness, were given as A2, G5, and K0. This simple observation by a ten-year old girl checks perfectly with the spectral types of the cluster stars, and tells us that the Beehive belongs to Trumpler's type 2a, and Shapley's Hyades type.

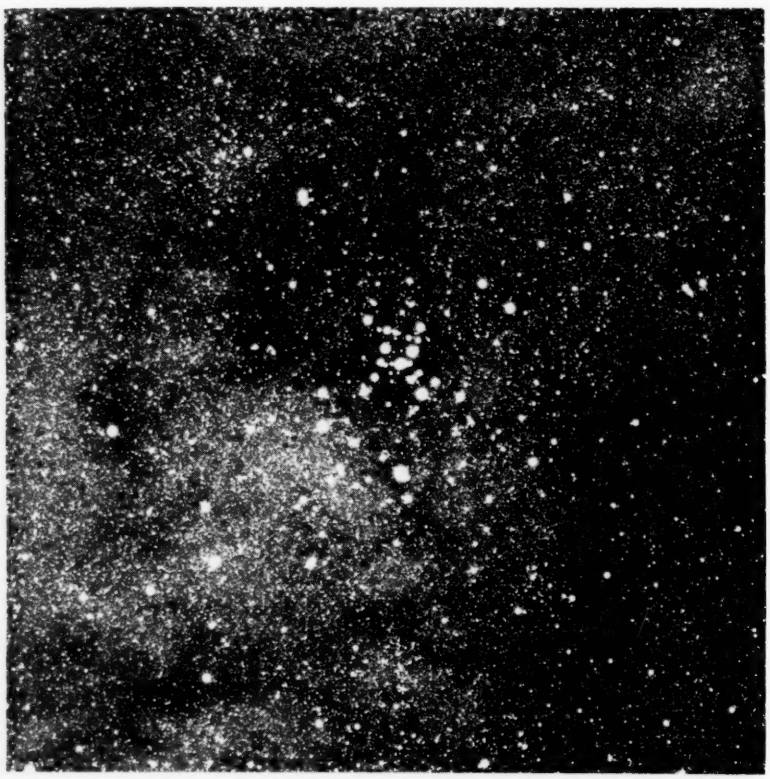
As mentioned before, observers will differ as to the colors they see in the stars. The author once showed a very red star to a group of novices and asked each to tell what color they would call the star. The answer included yellow, orange, reddish, salmon pink, rosy, deep yellow, pinkish orange, and coral. This would indicate that a star called "orange-colored" by one observer would be perceived to be any color between yellow and rosy by others. There is one way to avoid this confusion. Observe a sequence of stars representing all spectral classes and associate the colors of these stars with the spectral class. Compare your unknown star with those in the standard sequence. In this way, it does not matter what you *call* the color; it only matters that the color you *see* is associated with its proper spectral class.

Experience has shown that an estimate of color or of spectrum should not be made too quickly after having looked at the chart with artificial light. Every time this is done, the star will appear much too blue. A full minute or more should elapse between looking at the chart and estimating the spectrum of a star.

Very faint stars will show no color. Do not try to estimate color or spectrum of stars too near the threshold of visibility. Experience seems to indicate that successful observation of color cannot be made within two and a half magnitudes of the limit of magnitude visible. Naked eye observations should be confined to stars brighter than about magnitude 3.5; a telescope showing stars to magnitude 11.0 (a three-inch) can be used in color observing not fainter than about 8.5 magnitude, and so on.

Estimates of color of the lesser components of double stars are probably useless, except for their aesthetic value. Faint companions of doubles, regardless of type, sometimes seem to be of the color *complementary* to that of the brighter. You probably recall many pairs in the lists with the combinations of yellow and violet, orange and blue, red and green. The color of the fainter is often spurious, although not always.

Observing the colors of stars and estimating their spectral types creates an added interest in stellar astronomy. While at the eye-piece, one makes his estimate, and at once knows a great deal about a star, although he may never have seen it listed in a catalogue and it appears on his chart only as small black dot.



Messier 7, just above the tail of Scorpius, falls into Shapley's Hyades-type classification, containing some yellow and orange stars. As these stars are fairly bright in this cluster, one can make assumption that the brightness of these yellow, less luminous stars indicates cluster is closer to us (390 parsecs) than Double Cluster in Perseus, for example (next page), a Pleiades-type cluster. (Photo by Alan McClure, using 7-inch f/7 Fecker triplet lens, with plate exposed for 20 minutes in blue light).

Double cluster in Perseus, photographed by Alan McClure. This Pleiades-type cluster contains bright bluish-white and white stars of apparent magnitudes not much brighter than those in Messier 7. Cluster's distance, some 1,200 parsecs (4,300 light years), can be inferred from these observed facts.

Through a knowledge of the characteristics of stars of each spectral class, one has a real indication of the temperature, diameter, mass, density, intrinsic luminosity and other details. Of course, one must hold the mental reservation that the particular star under observation may be a dwarf, and not obeying the usual rules, but in most cases it will be in the giant class. When noting colors of the brightest stars of a cluster, one knows that they are giants averaging about 0.0 absolute magnitude (brightness as seen from 10 parsecs, or 32.6 light years). This fact, coupled with the spectrum estimate, gives the observer a good indication of the distance and type of the cluster. In the case of the Pleiades type, the brightest stars usually will be somewhat more luminous than in the Hyades type. Speculation on the relative distances of the clusters based on one's own observations is a most interesting exercise.

The observational material which has been presented demonstrates that, by noting the colors of stars as associated with spectral class, reasonably accurate estimates of class can be made. These estimates, coupled with a good knowledge of the meaning of stellar spectra, opens a great new field for observation and intellectual speculation, with both accomplished at the eye-piece. Where can we find greater enjoyment of the stars?

STARS FOR COLOR OBSERVATIONS

Below is a selected list of stars for color observation, listed with their spectral class. These stars may be identified on the July and August monthly sky maps on pages 18-19 of this issue. The stars can be used as a basis of comparison in estimating the colors and spectral classes of other nearby stars. Serious observers should later compare their estimates with spectral classes as listed in such sources as the RASC *Handbook*, Schlesinger's *Catalog of Bright Stars* (1940), or the *Atlas Coeli II Katalog*.

Gamma Pegasi	B2	Epsilon Cygni	K0
Alpha Pegasi	B9.5	Delta Andromeda	K3
Alpha Cygni	A2	Beta Andromedae	M0
Gamma Cygni	F8	Beta Pegasi	M2
Eta Pegasi	G8		

MINOR PLANET NOTES

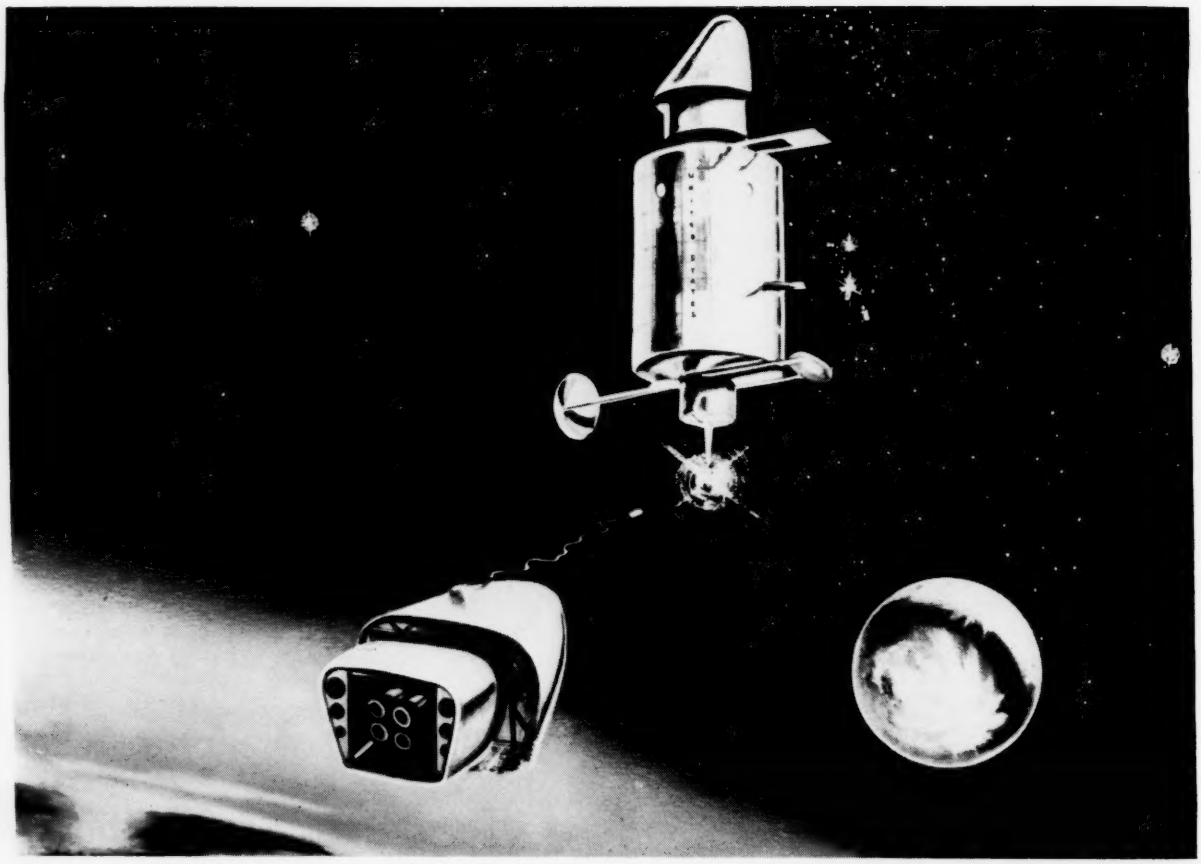
Observers with star atlases showing fainter stars (to magnitude 9) will have no trouble in following Flora and Juno as they come into opposition during the next two months. Pallas is in unfavorable opposition this time and is disappointingly faint. Amphitrite and Dembowska (we didn't name it!) are also faint.

Amateurs following asteroids fainter than their charts will find that they can locate the field, then spot the asteroid after a night or two by noting its daily motion among the stars. A rough sketch of the field on the first night will afford quick identification on the second night. The steadiness of their light is often an indication, as well.

The ephemerides below are furnished through the courtesy of the Minor Planet Center at the Cincinnati Observatory. Positions are given for ten-day periods, plus the number designation and name of the asteroid, and the date of opposition and maximum predicted brightness.

BRIGHT MINOR PLANETS
July-August 1961

Date (Oh UT)		RA h	m	Dec °	′
	29 Amphitrite 7/2 10m5				
6	10	19	06.4	−32	00
	20	18	57.9	−32	25
	30	18	47.5	−32	41
7	10	18	36.7	−32	43
	20	18	26.7	−32	33
	30	18	18.5	−32	13
	349 Dembowska 8/2 10m				
7	30	22	12.9	−24	12
8	9	22	05.3	−24	57
	19	21	56.5	−25	34
	29	21	47.7	−25	58
9	8	21	39.7	−26	05
	18	21	33.6	−25	54
	2 Pallas 9/7 9m3				
8	9	23	21.4	+ 6	24
	19	23	16.2	+ 4	53
	29	23	09.6	+ 3	01
9	8	23	02.2	+ 0	55
	18	22	54.7	− 1	19
	28	22	47.8	− 3	33
	8 Flora 9/13 8m8				
8	19	23	42.9	−11	09
	29	23	37.4	−12	40
9	8	23	29.6	−14	13
	18	23	20.8	−15	35
	28	23	12.6	−16	34
10	8	23	06.4	−17	02
	3 Juno 9/18 8m5				
8	29	23	53.5	+ 0	01
9	8	23	48.2	− 1	52
	18	23	41.6	− 3	58
10	8	23	28.6	− 8	02
	18	23	24.5	− 9	37



Orbiting space laboratories, such as this conception proposed by Martin Aircraft, may be the astronomer's last refuge from the ever-growing clutter of earthbound skies. Author McClure, a highly respected astrophotographer, presents some salient facts about man's race into space and expresses some opinions about the results. (Martin Aircraft Company).

THE VANISHING SKY

ALAN MCCLURE

In gaining space might man lose the beauty of the night sky? Astronomers, both amateur and professional, are increasingly concerned by new space projects being considered now. To gain the light of new knowledge, must we "set fire to the last forest?"

THROUGH THOUSANDS OF YEARS the night sky as we know it has remained relatively unchanged. Now, however, thoughtless and uncontrolled space activities threaten to brighten and change the appearance of the night sky within a few short years and seriously hamper earth-based astronomical observations.

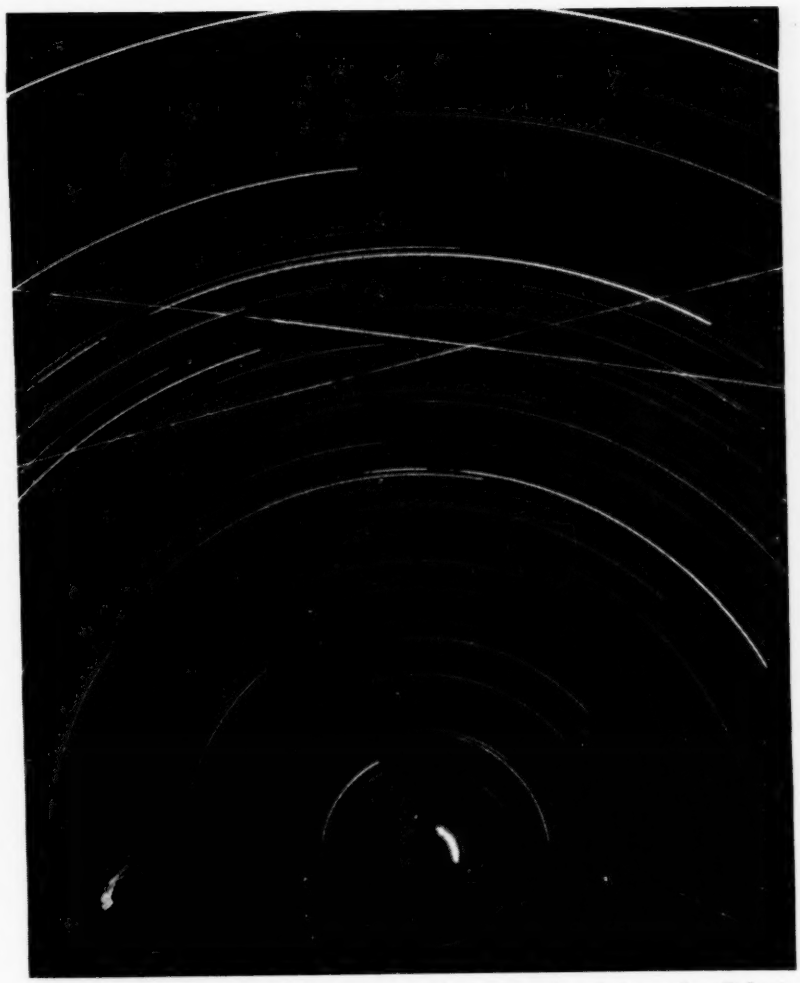
This may seem like quite an accusation to those of us who have always thought of the night sky as eternal. But plans about to be carried out over the next few years could cause severe setbacks to astronomy, not to mention the devastation of a vast natural realm. Thus, the "space age," with its promise of exploration and discovery, seemingly has also brought with it the threat of a sky cluttered with man-made debris ranging in size from millions of tiny wires

(Project Westford) to a system of nearly 100 Echo-type balloons (Project Rebound). These plans threaten to increase the brightness of the night sky and clutter it with bands of light and dozens of very bright artificial stars—resulting in a radical change in its visual aspect.

Recent predictions suggest that we will have placed 2,000 to 5,000 man-made objects into orbit by 1970, and The American Bar Foundation has warned that nations of the world might very easily turn space into a junkyard for all sorts of debris unwanted on earth. We should not underestimate the possible adverse effects of a large number of space programs being rammed through at "crash program" speeds. In this regard Dr. A. B. Meinel, associate director of the Kitt Peak National Observatory, recently communicated the following in a letter to the writer: "While it is hard to say that any one experiment is harmful, the trend is disturbing. . . . One solution for astronomers is to plan on placing our future observatories in high orbits or on the rear of the moon as a last resort."

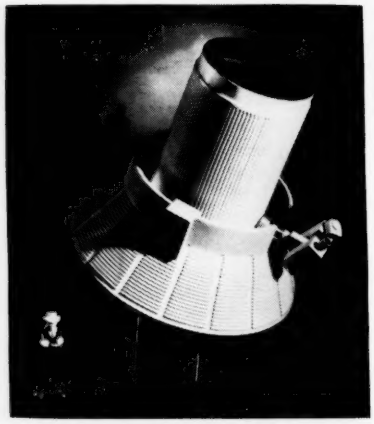
But let us now take a closer look at some of the more threatening of these programs. "Project Westford" is the current name for a scheme to orbit two belts of tiny, whisker-like wires (dipoles) for military communications purposes. Formerly called "Project Needles," this plan is to be carried out by the Air Force. The belts (one polar and one equatorial), consisting of needles about ½-inch long and one-third the diameter of a human hair, will probably be placed at altitudes of from 2,000 to 6,000 miles. Astronomers have become concerned that Project Westford may hamper both radio and optical astronomy. A test belt consisting of 75 lbs. of needles is due to be orbited in the near future, but later belts may contain up to a *ton* of material. These belts would reflect and scatter both radio and light waves, thereby brightening the night sky and affecting all sorts of astronomical measurements. Since the test belt will probably be visible to our eyes under favorable conditions, the later operational belts most certainly would be. We might see the later belts not unlike two false narrow "Milky Ways."

If the first test belts show promise we may find both military and commercial interests exerting great pressures for the orbiting of large amounts of material, since the efficiency of the "orbital scatter" method of communication increases with the amount of material in orbit. Apparently these interests, described by one astronomer as "entirely mission oriented," cannot be relied upon to give adequate consideration to the preservation of the night sky for pure research and the contemplation of man.



The Echo I balloon caught in two successive passes, by photographer Robert E. Cox of the McDonnell Aircraft Corp. Plans for increasing number of such balloons would threaten astronomical photography as night sky becomes criss-crossed with bright streaks.

Most of us have become familiar with the bright 100-ft. Echo I balloon, the lifetime of which has far exceeded the National Aeronautics and Space Administration's prediction of "a few weeks." Originally, proposals were to orbit a system of about 50 of these balloons for a "passive" communication system. However, as development and tests continued the much smaller and less conspicuous repeater-type satellites were found to offer more promise and communications interests shifted their emphasis to this type. For example, in a February, 1961, interview published in the Los Angeles *Times*, Dr. John R. Pierce, director of research-communication principles for Bell Laboratories, said that his company hoped to have an experimental active (repeater) satellite operating within a year. Dr. Pierce expressed the opinion that the "passive" satellites (such as Echo) were not as desirable as the "active" type.



Model of proposed orbital space telescope which may become a necessity if bright balloon satellites and orbiting "needles" are launched in any quantity. (AURA)

The natural course of events thus seems to indicate that we need not be worried about the orbiting of large numbers of Echo-type balloons. (It would seem that the radiation-pressure and atmospheric-drag experiments could be satisfactorily carried out by NASA's much smaller 12-ft. "polka dot balloons.") However, in spite of the apparent undesirability of the system, NASA has announced that it hopes to orbit, in late 1962 or early 1963, a system (as many as 90) of long-lived, stiffened 135-ft. Echo balloons. At its best this program, known as "Project Rebound," will give some dead communications time, and it appears that it would be replaced within one or two years by a superior "active" satellite communication system. As a forerunner, NASA plans to orbit a single 135-ft. stiffened Echo II in 1962, and a later Project Rebound system probably will incorporate the orbiting of up to three stiffened Echo balloons from one launch vehicle. (Even later plans call for the orbiting of six balloons from one launching vehicle.)

When Project Rebound is in operation, those of us wanting to identify constellations and locate ourselves in relation to the night sky would first have to single out all the bright, slow-moving "stars" (the altitude and orbital inclination of the current Echo make its passages visible all night during summer and most of the night during winter). The author submits that anything which significantly changes the appearance of the night sky must be considered a disfigurement. Along with this disfigurement, Project Rebound would confront us with the undesirable brightening of the night sky and consequent interference with astronomical observations. Dr. N. U. Mayall, director of the Kitt Peak National Observatory, has stated in a letter to the writer that he feels that "a large number of satellites like or larger than Echo I could be a real nuisance to some types of astronomical photography." In his letter Dr. Mayall refers to the passage of such objects *near* the field being photographed, and not necessarily through it.

Surely, at this point, we might wonder why NASA is planning a system which appears to be inefficient and undesirable, even on purely practical grounds, and which duplicates other more efficient types. In addition to readying Project Rebound with its passive Echo, NASA is also developing an active satellite (Project Relay). In the passive-satellite field the Air Force is developing a more sophisticated "lens-studded" device which offers promise of improved efficiency. We should also not forget the U. S. Army's highly successful Courier satellite (active), which is the forerunner of the more advanced "Advent" system.

There seems little doubt that NASA obtained a tremendous amount of attention from orbiting the conspicuous Echo I balloon, and it would appear to the author that Project Rebound will mainly serve the purpose of attracting further attention to NASA and its activities. In SCIENCE NEWS LETTER for March 11, 1961, an article entitled "U. S. Forces Race in Space" stated that the U. S. is now competing with itself as well as Russia. Competition between NASA and the Air Force was cited as the main problem, although inter-service rivalry was also said to have entered the conflict. The article concluded with the statement: "Orderly, long-range and imaginative planning under unified command appear to be required if the waste of self-competition is to be avoided."

Projects Westford and Rebound are not the only threats to be faced. A few years ago one of the military came up with the idea of placing large quantities of sodium vapor into orbit. The rsult of this plan would be permanently to raise the illumination of the night sky to about that of the full moon. If carried out, this could have many repercussions — besides causing an astronomical disaster. Fortunately, there are at present no known plans for carrying out this scheme, but recently an official of a large western aerospace firm proposed the idea that rockets might be satisfactory for all sorts of advertising stunts. Suggestions included orbiting clouds of powder in the shape of words and a fireworks display visible over the entire country. These proposals, possibly involving the use of Atlas missiles when they become "surplus," may seem far-fetched today, but our accelerating technology could make them possibilities all too soon.

If we are to accept the premise that some of these programs are a threat, we might say that, surely, when the orbiting astronomical observatories are put into operation earth-based observations will be obsolete. The answer is that, even for the professional, the classic earth-based observations are still the backbone of astronomy. Satellite astronomy will cause some spectacular breakthroughs (in the ultraviolet range of the spectrum, for example), but any serious hampering of earth-based observations might more than offset these. Also, projects such as Westford threaten observations made from satellites—in all but extremely high orbits—by increasing the brightness of the night sky as seen when these satellites are facing in the direction of the belts. In regard to this critical-brightness problem, one astronomer

Project "Needles" would threaten rapidly advancing radio astronomy as well as optical telescope research. (Courtesy "The Amateur Scientist")

said that he felt (referring to earth-bound observations) that "an increase in the sky illumination of as much as one percent for any period of time will hamper those working to the limit of their telescopes."

Of course, what affects the professional astronomer will also affect the amateur, and even the man in the street. In a sense the night sky is part of the heritage of everyone. Should future generations, as well as the present, be faced with the results of thoughtless or wanton destruction of the natural scene? While some might scoff at these "esthetic" considerations, the loss or disfigurement of the night sky has its tragic overtones.

Even before the Russian orbiting of a man, the United States Information Agency's controversial report, which figured in the 1960 presidential campaign, showed that public opinion in most of the world believed Russia to be ahead of the U. S. in space achievements. Your author submits that, in our race for "prestige," we cannot make up for Russia's spectacular "firsts" with a series of "space gadgets," even though some of these give valuable scientific information. In other words, even the establishment of a much-touted worldwide television network is unlikely to achieve the primary objective of our space program—mainly that of raising our international prestige. Owing to commercial pressures, communications satellites seem recently to have received more than their share of attention, while other projects of benefit to mankind, such as a system of weather satellites, have been underplayed. Furthermore, the impact of an extremely sudden breakthrough in mass communication needs more consideration. Whatever happens we can ill afford to become known as the nation that contaminated space. It is an interesting legal question whether or not any nation has the right to contaminate the skies over another. Our fast-moving technology gives us increasing power to alter and destroy, but this is insufficient justification for carrying out harmful plans. Rather, our technology carries the implicit responsibility of making the proper choice regarding the long-range benefit of mankind.

The need for preservation of the night sky has been well put to the writer recently by Henry L. Giclas of the Lowell Observatory, who writes: "Of course, I feel the greatest argument for control of what is put in the sky should be that astronomical observations have not only provided us with the fundamental laws of mechanics and order, but the most fundamental concepts of matter and energy. I do not believe we have begun to exhaust this physical laboratory which has opened such new and radical concepts to man's mind and imagination that he could never possibly have conceived or attempted the experiments on earth that have brought us to this point of progress. To jeopardize this unique and fruitful source of original data with man-made contaminants is most short-sighted and presumptive on his part."

At present most of the confusion and duplication seems to lie in the realm of communications systems. However, it is quite possible that lack of consideration of the long-range consequences may even cause some space programs to interfere with each other. Albert Einstein, in an address given in 1931, pointed out problems which seem all too familiar to us 30 years later. Dr. Einstein said: "Concern for man himself and his fate must always form the chief interest of all technical endeavors. Never forget this in the midst of your diagrams and equations."

Recently much effort has been directed toward preserving and protecting our national parks from all sorts of vandalism, yet at the same time substantially no consideration has been given to the tragic implications of the ravaging of the last and *only* night sky. These problems only serve to point out the urgent need for international control, for even if we succeed in controlling our own agencies, we have not guaranteed that other countries, such as Soviet Russia, will not carry out harmful space programs.

Less than four years have passed since the commencement of the "space age," and already we find alarming trends. Certainly it appears that the scientific and public interest is best represented by keeping the night sky more or less as it used to be. As with other serious problems now facing mankind, international cooperation through agencies such as the U. N. Committee on the Peaceful Uses of Outer Space seems to be the only satisfactory answer.

In conclusion, it seems most appropriate to quote from a letter received from Dr. Frank Drake, of the National Radio Astronomy Observatory, who has communicated: "It is clear that space technology has reached a state where it has a potentiality to harm other fields of science and everyday life. A close watch must be kept to insure that dangerous undertakings are nipped before they occur. There will obviously be a need in the near future for an international forum in which all the ramifications of an experiment can be discussed and a consensus of international opinion obtained as to the pros and cons of an experiment, with a final opinion as to whether the experiment should be done at all. We can hope that mankind will face up to this responsibility and carry it out without allowing petty political considerations and propaganda opportunities to corrupt the purpose of the organization."

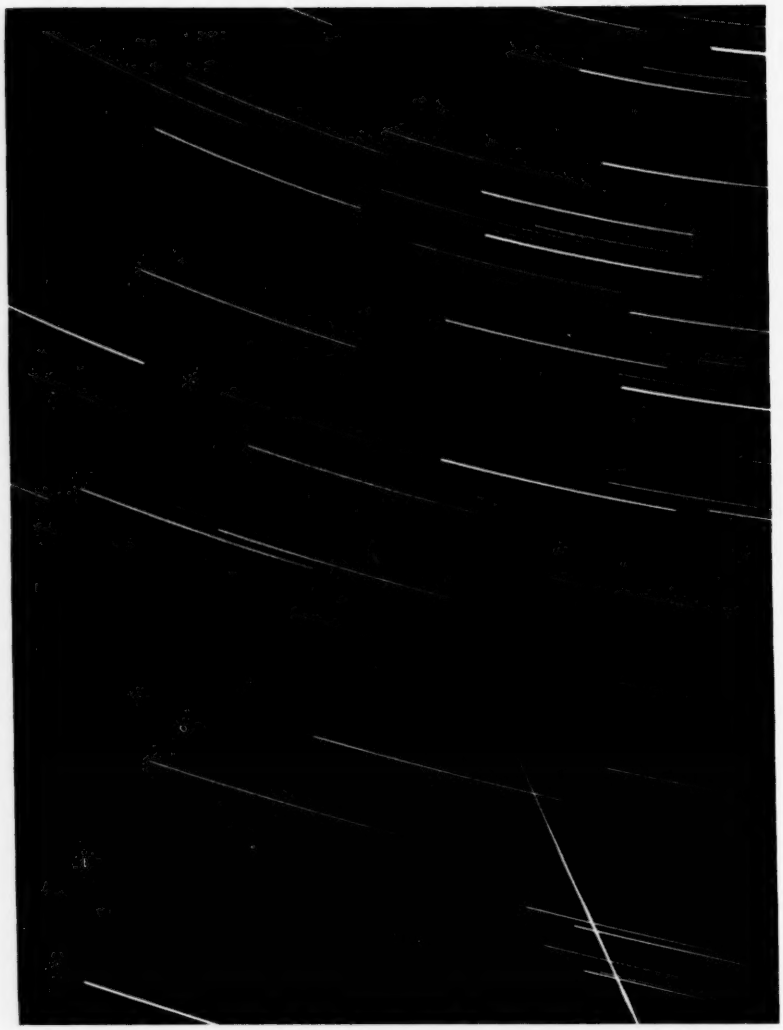
A Summer Night

No moon intrudes with garish light
Upon the velvet of the night,
No cloud's obscuring curtain mars
The panorama of the stars, ——
Urania's jewels, scattered there
That mortals may their beauty share.

Serene and clear, the heavens display
The silver of the Milky Way,
And stately on their journey go
The constellations wheeling slow.

Think, if the Seraphim who tread
The shining pavement overhead
Should gather up and make their own
The gems that are before them strown,
How great our loss, for there would be
No dome of stars for us to see.

N. Lincoln, Bloemfontein, South Africa



A bright Perseid meteor cuts through Delphinus before leaving field of camera. Photographed by David Megginson on Aug. 11th, 1958, using f/3.5 Ciro-Flex. Fireball was estimated at −8, left train for 31 seconds.

ASTRO-TOPICS

DR. I. M. LEVITT

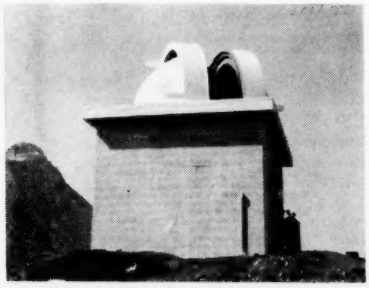
AUGUST IS "METEOR MONTH"

ABOUT AUGUST 12 the Perseid meteors will be flashing through the skies to put on the best display of the year. [See "*Meteor Fragments*," p 16.] In the early morning hours of Saturday, if the sky is diligently watched, an observer may see as many as one meteor per minute. (On any ordinary night you see about one an hour.) The meteors will appear to come from the northeast in the constellation of Perseus, and though they may appear in any part of the sky, if the path is traced back the origin of the path will be somewhere near Perseus. The Irish peasants called the Perseide the "tears of St. Lawrence," because his feast falls on August 10.

Most people call meteors "shooting stars," but meteors are about as unlike stars as they can be. Stars are bodies like the sun—millions of times the size of the earth—whereas these "shooting stars" are tiny particles, no larger than a grain of sand or the head of a pin. The Perseid which flashes into our sky and appears as bright as the North Star is no larger than the head of a pin—some 5,000 of them would weigh an ounce. The reason for their brilliance lies in the speeds with which they enter the atmosphere. The Perseids move with a speed of about 40 miles a second and as a consequence possess a great store of energy.

When the meteor plunges into the atmosphere nothing happens until it reaches an altitude of about 60 miles. At this altitude there are enough atoms and molecules of air to furnish resistance to the passage of the meteor. The atoms of the atmosphere chip and splinter atoms from the surface of the meteor and send these particles which have been heated to about 4,000 degrees flying. So many of the meteor atoms are showered away from the meteor that the succeed in heating a colum of air many feet in diameter to incandenscence. It is this column of air which is seen and is called a shooting star. The entire meteor is consumed and the only thing remaining after the passage of the meteor is a column of broken up atoms which cannot be seen but can be detected with instruments like a radar set.

The reason for the existence of the meteor shower lies in the vast amount of cosmic debris which is prevalent in space. Today we know that comets and meteors are related. What created comets is not known, but because there are comets, we have meteors. This discovery goes back more than 100 years. In 1866 the Italian astronomer Schiaparelli noticed that the elements of the orbits of Swift's comet of 1862 and the Perseids were almost identical. This disclosure indicated that there was a relationship between the two. Today we explain the existence by saying most comets leak little particles, which in ordinary circumstances would follow along behind the comet. However, sometimes the comet gets close to the large planets and the planetary perturbations or disturbances cause the particles to leave the comet and distribute themselves uniformly in the orbit. As a result there are many places in the solar system where these tiny particles are found. In mid-August the earth, in its motion around the sun, happens to intersect the orbit of the Perseids, resulting in the meteor shower.



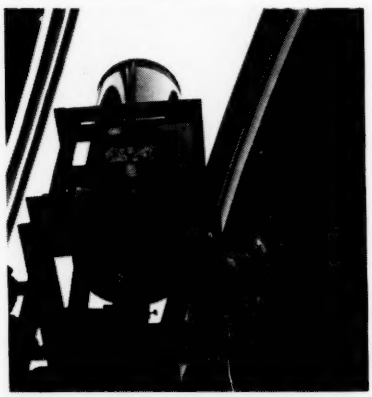
New Organ Pass Observatory

TV OBSERVATORY DEDICATED

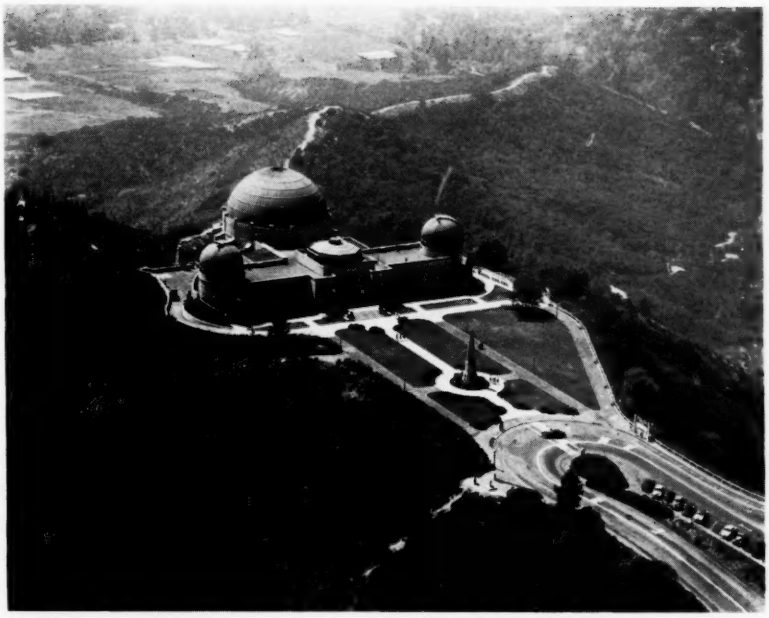
An observatory "wired for television" was dedicated recently in Organ Pass, Texas. A branch of Northwestern University's Dearborn Observatory, the new facility is scarcely an "arm-chair astronomer's" paradise. Rather, it is designed to take advantage of the new electronic techniques of image amplification in order to do special research in stellar astronomy.

At the dedication, Dr. J. Allen Hynek, director of the Dearborn Observatory, stated that the television system incorporated in this new installation will render the small telescope as effective in reaching faint stars and other objects as many of the larger telescopes in the world today. Under direction of Dr. Hynek, the observatory at Organ Pass will be manned by a staff of observers and technicians.

Dr. Hynek assumed his post as Dearborn Observatory director last fall after a long tenure as associate director of the Smithsonian Institute Astrophysical Observatory in Cambridge, Mass. He was also director of the visual and optical satellite-tracking program, which included Operation Moonwatch.



Observer's-eye view of new TV telescope incorporating electronic image amplification techniques. Photos courtesy of Dr. J. Allen Hynek.



Grounds of Griffith Observatory and Planetarium, overlooking Los Angeles and environs. Star party on grounds is tentatively planned as one of many features of Western Amateurs Convention to be held in nearby Long Beach Aug. 24-26, 1961. (Griffith Observatory photograph.)

CONVENTION NOTES

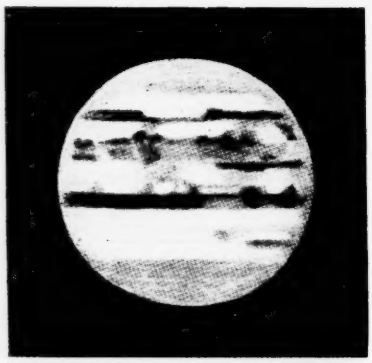
WESTERN AMATEURS MEET IN AUGUST

Two panels, two Morrison Foundation Lectures, two star parties, and two days of papers by prominent amateur astronomers of the Western Astronomers meeting which is scheduled for Aug. 24-26, 1961, in Long Beach, Calif. To complete the "binary" nature of the meetings, the three-day session is actually the combined conventions of both the WAA and the Association of Lunar and Planetary Observers.

The panels will include a "Stump the Experts" group composed of professional astronomers, and the remaining panel will feature such well known amateurs as George Carroll, Arthur Leonard, Roy Ensign and Alan McClure; their subject will be "Telescopes and Observing." The Morrison Lectures will be announced at a later date. On Friday evening, Aug. 25th, a public star party will be held in the early evening at Exposition Park expressly to observe the nearly total eclipse of the moon, after which the conventioneers will adjourn to another site, probably the Griffith Observatory area above Hollywood. As the eclipse will finish by 9:30 p.m. PDT, such an arrangement is quite feasible, convention planners feel.

Convention chairman Tom Cave expects to have extensive amateur, club and commercial exhibits, and estimates that attendance may run as high as 300-400 people. Reservations should be sent to the Lafayette Hotel in Long Beach, headquarters for the meetings. Rooms begin at about $6.50 (single). Convention registration is $3.00 per party, and advance checks should be sent to Mel Mattox, 3849 Atlantic Ave., Long Beach. Mr. Mattox is treasurer of the Long Beach Excelsior Astronomy Club, host society for the event.

Presentations filed at the time of publication include papers by the following amateur astronomers: Leif Robinson, Bernard Hammer, Ernest Lorenz, Richard Norton, Tom Cragg, Capt. C. Adair, Arthur Leonard, Dr. Clarence Custer, J. Russell Smith, Claude Carpenter, Jim Dougherty, Harold Kaiser, George Carroll, Tom Cave and Carl Wells. Wells will be awarded the WAA's Blair Medal for his contributions to West Coast amateur astronomy.



Jupiter, as observed and drawn with a 4-inch refractor (200x) by British observer G. E. D. Alcock, Dec. 8, 1952. Per-inch power can be pushed higher on smaller apertures than on moderate apertures. From BAA Journal.

THROUGH THE THREE-INCH

Observing Jupiter And Its Satellites

Observable Phenomena of Jupiter's Satellites

JULY				AUGUST			
Date	Time (EST)	Satellite	Phen.	Date	Time (EST)	Satellite	Phen.
1	00:20	I	ED	1	01:42	I	Te
	03:13	I	OR		01:53	I	Se
	23:46	I	Se		20:42	I	OD
2	00:20	I	Te		23:11	I	ER
5	23:49	II	ED	4	23:24	III	ER
6	01:22	IV	OR	6	22:55	II	OD
7	22:38	II	Te	7	02:29	II	ER
8	02:14	I	ED	8	01:09	I	TI
	23:23	I	SI		01:23	IV	OD
	23:47	I	TI		01:30	I	SI
9	01:40	I	Se		20:41	II	Te
	02:04	I	Te		21:24	II	Se
	23:23	I	OR		22:26	I	OD
10	22:48	III	Te	9	01:06	I	ER
13	02:25	II	ED		21:53	I	Te
14	00:43	IV	SI		22:17	I	Se
	03:18	IV	TI	11	22:00	III	OD
	22:01	II	TI	14	01:12	II	OD
15	00:22	II	Se	15	20:05	II	TI
	00:53	II	Te		21:08	II	SI
16	01:17	I	SI		22:56	II	Te
	01:31	I	TI		23:59	II	Se
	22:37	I	ED	16	00:11	I	OD
17	01:06	I	OR		21:20	I	TI
	21:46	III	SI		21:54	I	SI
	22:03	I	Se		23:38	I	Te
	22:14	I	Te	17	00:12	I	Se
	22:30	III	TI		21:29	I	ER
18	01:20	III	Se	19	01:21	III	OD
	02:05	III	Te	22	21:23	III	Se
22	00:05	II	SI		22:22	II	TI
	00:15	II	TI		23:43	II	SI
	02:57	II	Se	23	01:13	II	Te
	03:06	II	Te		23:06	I	TI
23	03:11	I	SI		23:49	I	SI
	03:15	I	TI	24	01:24	I	Te
	21:18	II	OR		20:23	I	OD
24	00:31	I	ED		20:28	IV	OR
	02:50	I	OR		21:04	II	ER
	21:40	I	SI		22:45	IV	ED
	21:41	I	TI		23:23	I	ER
	23:58	I	Se	25	19:51	I	Te
	23:58	I	Te		20:36	I	Se
25	01:46	III	SI	29	21:48	III	SI
	01:47	III	TI		22:03	III	Te
	21:47	I	ER	30	00:41	II	TI
29	02:27	II	TI	31	00:53	I	TI
	02:40	II	SI		22:09	I	OD
30	20:39	II	OD		23:42	II	ER
	21:58	IV	Te				
	23:19	IV	Se				
	23:51	II	ER				
31	02:16	I	OD				
	23:25	I	TI				
	23:35	I	SI				

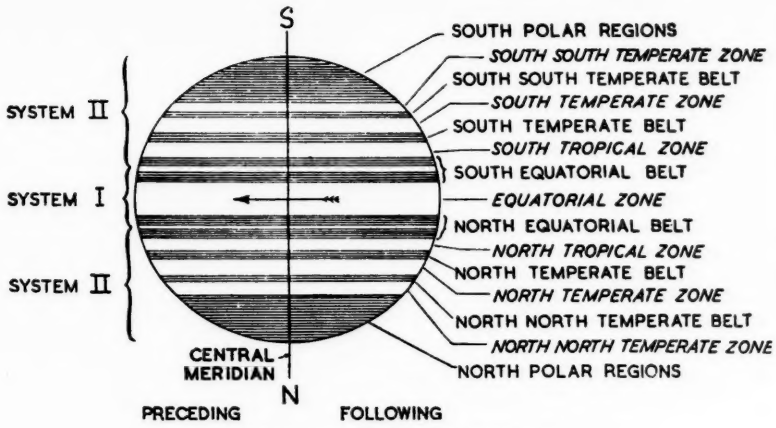
(Times EST) E—eclipse (satellite passes into shadow of planet); O—occultation (satellite passes behind planet; T—transit (satellite or satellite shadow passes across disk of planet); S—shadow (shadow of satellite cast on disk by sun); D—disappearance; R—reappearance; I—ingress (entrance upon disk); e—egress (exit from disk). Satellite designations; I—Io; II—Europa; III—Ganymede; IV—Callisto.

THE WRITER STILL REMEMBERS his first telescopic view of the planet Jupiter with delight—possibly because it was his first telescopic glimpse of *any* celestial object, but more likely because Jove and his retinue of satellites is by far the most striking sight in the heavens for the uninitiated eye. "Someone in every town should own a telescope!" wrote Robert Frost in his splendid poem about the man who burned down his barn to collect insurance in order to buy himself a telescope; and while we can suggest that our modern economy has provided us with less extreme methods of obtaining a telescope, we cannot disagree wiht the idea. A man in our town *did* own a telescope, an excellent 3-inch Mogey refractor, and we visited his home for a look one summer night. And there it was—Jupiter, sailing into the field of view like a stately galleon, bright and clear, full of promise, and escorted by a host of moons.

A few weeks later—and thanks to this same benefactor—the writer was using a small 2-inch refractor on loan, and mainly on Jupiter. Even with a 2-inch, Jupiter came alive, and with it an abiding interest in the heavens.

On the 25th of July, Jupiter is in opposition, meaning that the planet is directly opposite the sun at midnight (local standard time), and therefore on the southern meridian. To say that Jupiter is in Capricornus is injudicious — rather Capricornus lies behind Jupiter, for the great planet dominates the summer evening sky for the next few months, while Capricornus has little claim to fame.

Jupiter is best "snuck up on." Start with your lowest power, and see it in its true perspective against the background star field, its disk and markings sharply defined and



NOMENCLATURE OF JUPITER

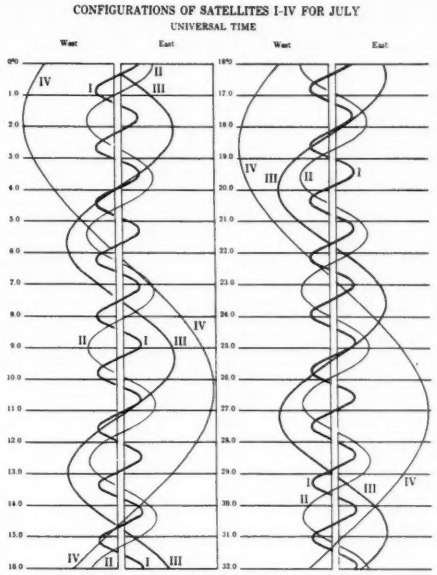
the satellites strung out like bright pearls on an invisible thread. Then add some magnification for more resolution.

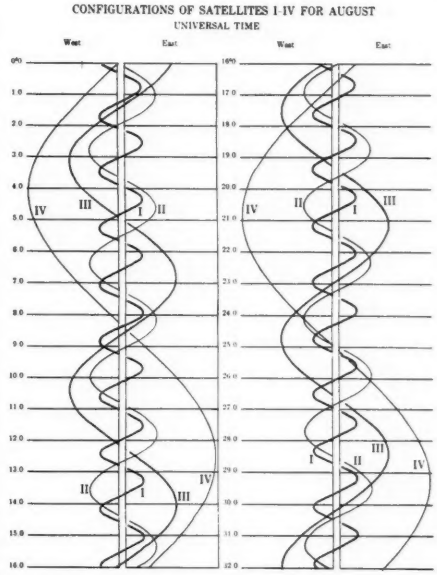
Observing Jupiter can be divided into two equally fascinating pursuits—the disk markings and the satellite phenomena. As with planetary observation of any sort, each cumulative hour of viewing will bring new detail to the retina, and this is nowhere more true than in the case of Jupiter. The equatorial belts will be quite obvious, and others will come quickly as the eye adjusts. Then, as the observer becomes more sensitive to the fainter details, spots, mottled areas and "festoons" bordering the edges of the belts will begin to spring into view. Now, we must not mislead the novice—a 3-inch telescope is limited in what it will show on the disk of Jupiter. But—and this is just as true—ten hours spent in observing the planet with a 3-inch will bring more detail to the fore than a 6-inch in the hands of the "gadabout" observer who skips from one object to another "just to make certain they're still there!"

One way to become more familiar with Jupiter's changing atmosphere —for that is what we see, not the actual surface—is to make drawings of the planet. These have to be made quickly to afford a true representation, for the planet, large as it is at some 87,000 miles in diameter, rotates on its axis in less than 10 hours. The accompanying schematic diagram of Jupiter's more-or-less permanent belts and zones can be of assistance in planning the drawing, orienting the belts in latitude, and familiarizing yourself with Jovian nomenclature.

One important piece of work the amateur can do, even with a small instrument, is to make timings of the meridian passage (across the center of the disk) of conspicuous markings such as spots, projections, festoons, etc. An experienced observer can estimate this central meridian passage (or transit) within a minute or two, and when a number of observations by several observers are weighted together a fairly accurate picture can be established of the atmospheric circulation on the planet at that time and in that place. Owing to Jupiter's great size and its rapid rotation, the movement of its equatorial zone in one complete rotation is some 5^m 10^s faster than in its temperate and polar belts and zones. These disparate rotation periods are of great interest to students of Jupiter and, through transit observations, the circulation of Jupiter's atmosphere can be studied with increasing benefit. An observer should record the time to the nearest minute (specifying time zone and using standard time), the belt or zone on which the transiting object is seen, and a brief description of the object itself. It was through transit observations such as these, made by amateurs, that the two circulation systems (I—equatorial, II—temperate and polar) were first discovered and defined. We suggest that you try a few after you gain a little experience, then send them to Mr. Philip R. Glaser, 400 E. Park Ave., Menomonee Falls, Wis.; he is Jupiter Recorder of the Association of Lunar and Planetary Observers and will be happy to work with you.

But, to the modest glass, the phenomena of Jupiter's satellites offer even more pure pleasure. In the days when man's mathematical skill had



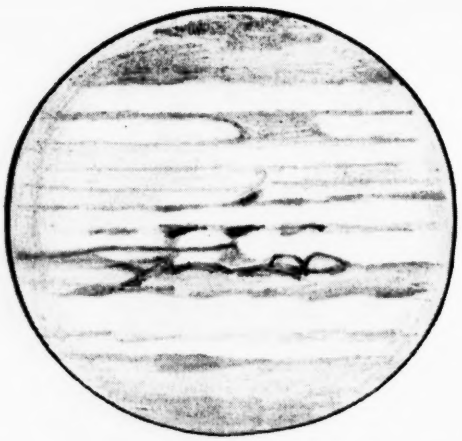


EXPLANATION OF DIAGRAM

The central vertical band in the diagram represents the equatorial diameter of the disk of Jupiter. The relative positions of the satellites at any time with respect to the disk of Jupiter are given by the curves. In cases where a satellite is immersed in the shadow of Jupiter or occulted by its disk, the curve is interrupted.

The horizontal lines show the positions of the satellites at Oh Universal Time (Greenwich Mean Time) for each day of the month. For example, the horizontal line for the 15th of this month would show the positions of the satellites at 7:00 p.m. on the 14th of the month for an observer in the Eastern time zone.

(Diagrams taken from 1961 *American Ephemeris and Nautical Almanac.*)



Jupiter (T. R. Cave)
8" reflector—230 power
April 2, 1959
8h 45m-9h 00m UT

Remarks: Seeing variable due to high, thin clouds. Nearly all System I very rust or brick red—very intense — many small white spots suspected on exact equator.

This drawing by Tom Cave indicates some of the planetary detail which can be grasped by an experienced observer using good optics. Main activity at time of drawing centers in northern component of Jupiter's equatorial belt (System I). Equatorial area has rotation period more than 5 minutes faster than rest of planet, requiring two systems for timing central meridian transits of planet's markings. South is at top.

temporarily outrun his physical knowledge, it was by noting the discrepancy between the predicted and observed times of Jovian satellite phenomena that Olaus Roemer, the Danish astronomer, made his first rough measurements of the speed of light. The predictions of the various phenomena which the four bright satellites of Jupiter undergo, and which are included in each issue of this magazine, allow for this time differential, and occur just about on schedule.

At and around opposition, you will observe two main events and a secondary one. An *occultation* of a satellite by the planet occurs when the satellite passes behind the planet's disk; a *transit* occurs when a satellite passes in front of the disk. A transit often includes the transit of the satellite's shadow, although at certain times when the plane of a satellite is sufficiently inclined to the earth, a shadow may transit "without" its satellite (or vice versa). Such is the former case in this issue's cover photograph.

Before or after opposition, when the planet's shadow falls to the west or east of the planet, respectively, a satellite may disappear before it reaches occultation or reappear after it has already undergone actual occultation by the planet's disk. Such "eclipse" disappearances and reappearances are also of some interest—the phenomenon is not immediate, but takes several minutes as the satellite enters or leaves the penumbral regions of Jupiter's shadow. The configurations of Jupiter's satellite are shown by the monthly diagrams included in each issue, enabling the observer to identify the four bright companions and to follow the various events listed in the phenomena tables.

Additionally, every five or six years the plane of Jupiter's satellites coincides with the earth, and this allows its satellites to create even further mischief. During this time the satellites eclipse and occult *themselves*. An occultation of one satellite by itself can easily be anticipated by watching the relative motions of two approaching satellites, but an eclipse is another matter, and of great interest. On the morning of Aug. 22nd, for example, satellite II will be partially eclipsed by the shadow of III from 1:14 a.m. to 1:24 a.m. (EST), according to predictions by the British Astronomical Association. After this, for the remainder of the year, these mutual satellite phenomena will occur, and in the next issue we shall spend more time on these matters. The region about Jupiter is a mass of space-piercing shadow-cones and, with the earth in the plane of the satellites' orbits, exciting observations — including possibly a few once-in-a-lifetime experiences—are in store for the determined observer during this time.

D. D. Z.

METEOR FRAGMENTS

Perseids Reign This Month

THE DELTA AQUARID shower will be at maximum during the morning hours of July 29th, when the rate, were it not for light of a just-past-full moon, would likely be about 20 per hour (including usual background of about 7 sporadic, or incidental, meteors). A saving grace, however, lies in the fact that the duration of the shower to ¼ strength is from about ten days *before* to ten days *after* maximum. Thus, a little arithmetic indicates a rate of about ten per hour on the 19th, three of which are likely to be Aquarids. Now, this is not much attraction for the casual amateur who goes out for a thrilling show, but the Delta Aquarids are of interest to the serious observer. For about the first five days there is more than a hour after moonset and before the beginning of morning twilight for good meteor observing. The radiant is at right RA 22^h 36^m, Dec. 17° S.; about 3° west of the star Delta Aquarii.

You will be happy to notice that the conditions for Perseid observations this year will be very good, as long as the weather cooperates. The maximum occurs on Saturday, Aug. 12th, at about 2 a.m., and the new moon will be on August 11th! The rate at maximum will probably be in the neighborhood of 50 per hour; although it is sometimes less, it is not infrequently greater, sometimes reaching some 70 or 80 per hour. The duration of the shower to one-quarter the strength at maximum is about five days, which means that the rate should be about 18 per hour 2½ days before and after maximum. The point from which the shower appears to originate, called the radiant, is about 5° north of Gamma Persei.

Meteoric astronomy is really one of the younger branches of astronomy. It was just about the beginning of the 19th century that astronomers began to officially recognize the fact that meteorites did come from space outside the earth. The Perseids were not recognized to be periodic until 1836 (by Quetelet), and Erman suggested three years later that the stream consisted of a complete ring of particles. (Naturally, this "ring" is the elliptical orbit of the Perseids about the sun.) The average distance between particles in this stream is about 75 miles, as pointed out by

Porter in *Comets and Meteor Streams*, and calculations using this figure and other factors—such as the earth's orbital speed, the duration of the shower, and the angle of intersection between the respective orbits—indicate that the thickness of the stream is of the order of 5 million miles. The Perseids are a very reliable shower and come when temperatures are very likely to be pleasant for most of our readers; therefore, they are very good with which to start one's meteor observing career.

As usual, the American Meteor Society will appreciate any properly made meteor counts on these showers, or, for that matter, on any night whatsoever. The most essential ingredients of a scientifically useful observation are: (1) The count must be for one hour or more, (2) It must be one person's *individual record*, not a group total. Each observer should record only the meteors he sees, whether any of them are observed by another or not. (3) The sky, nearby lights, and obstruction conditions affecting the area of sky observed must be at least half as good as a perfect country sky (this definitely means that counts made within or too near large cities are of no value).

The information which should accompany every hour's observing are: (1) Name and address, (2) Observing location, (4) Sky and locality conditions (1.0 is perfect, 0.9 is nearly so, 0.5 is half perfect, 0 is completely clouded), (4) Compass direction, and the altitude in degrees of the center of the observed area. (The horizon is 0, half way to the overhead point is 45 degrees, and overhead is 90 degrees in altitude.) (5) Beginning and ending times of periods, and kind of time used, (6) Number of meteors seen during each hourly period, (7) The date, given in the double-date system, as for instance the night of Aug. 11th, morning of the 12th, would be given as August 11-12, 1961. Observations should be sent to THE REVIEW OF POPULAR ASTRONOMY, and they will be passed on to the appropriate regional director where there is one active, otherwise to Dr. C. P. Olivier, president of the AMS.

Names of observers and results for the Perseid shower will be published in a later issue. Reports should be mailed as shortly after the shower as possible.

EDWIN E. FRITON
American Meteor Society

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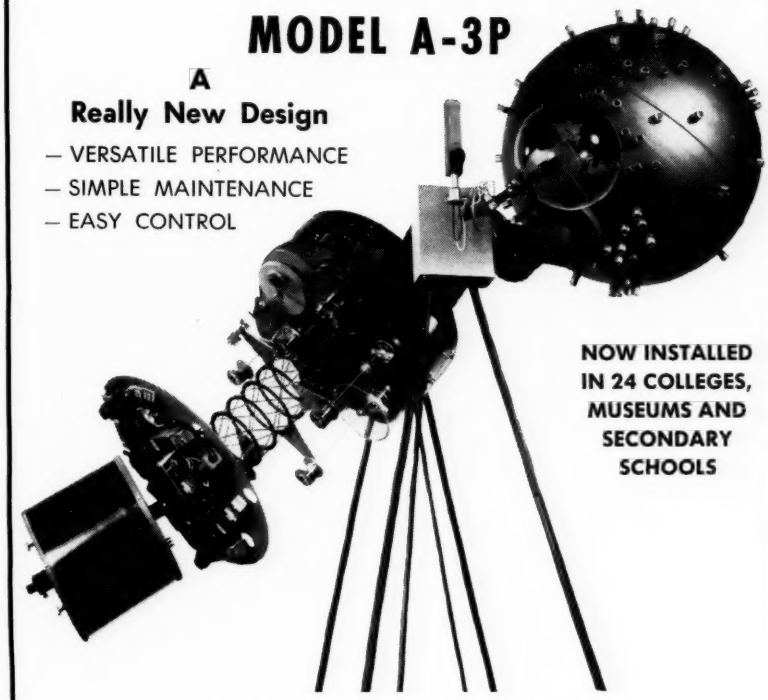

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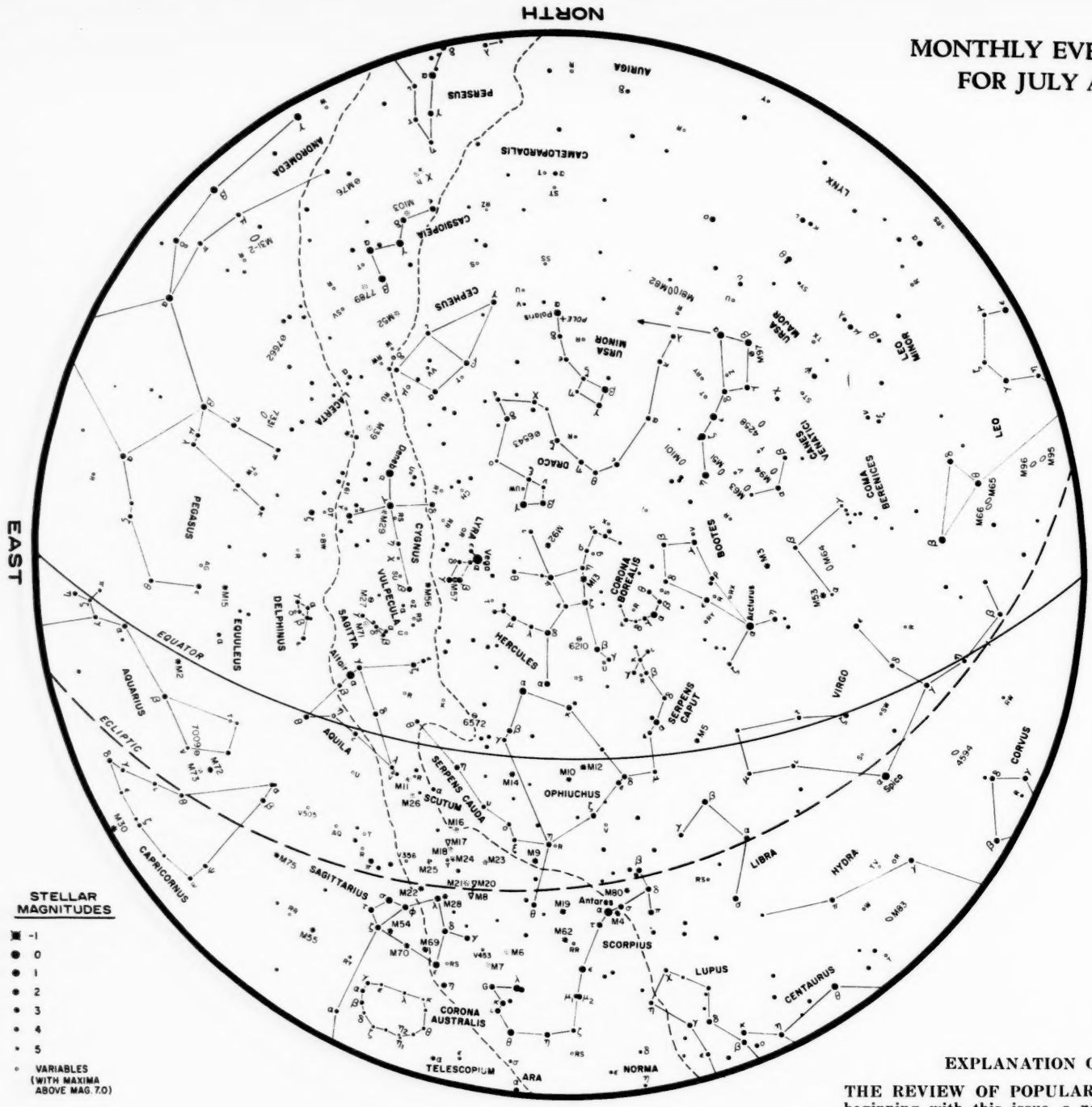


SKY MAP FOR JULY

July 1, 10:30 P.M. July 15, 9:30 P.M. July 31, 8:30 P.M.

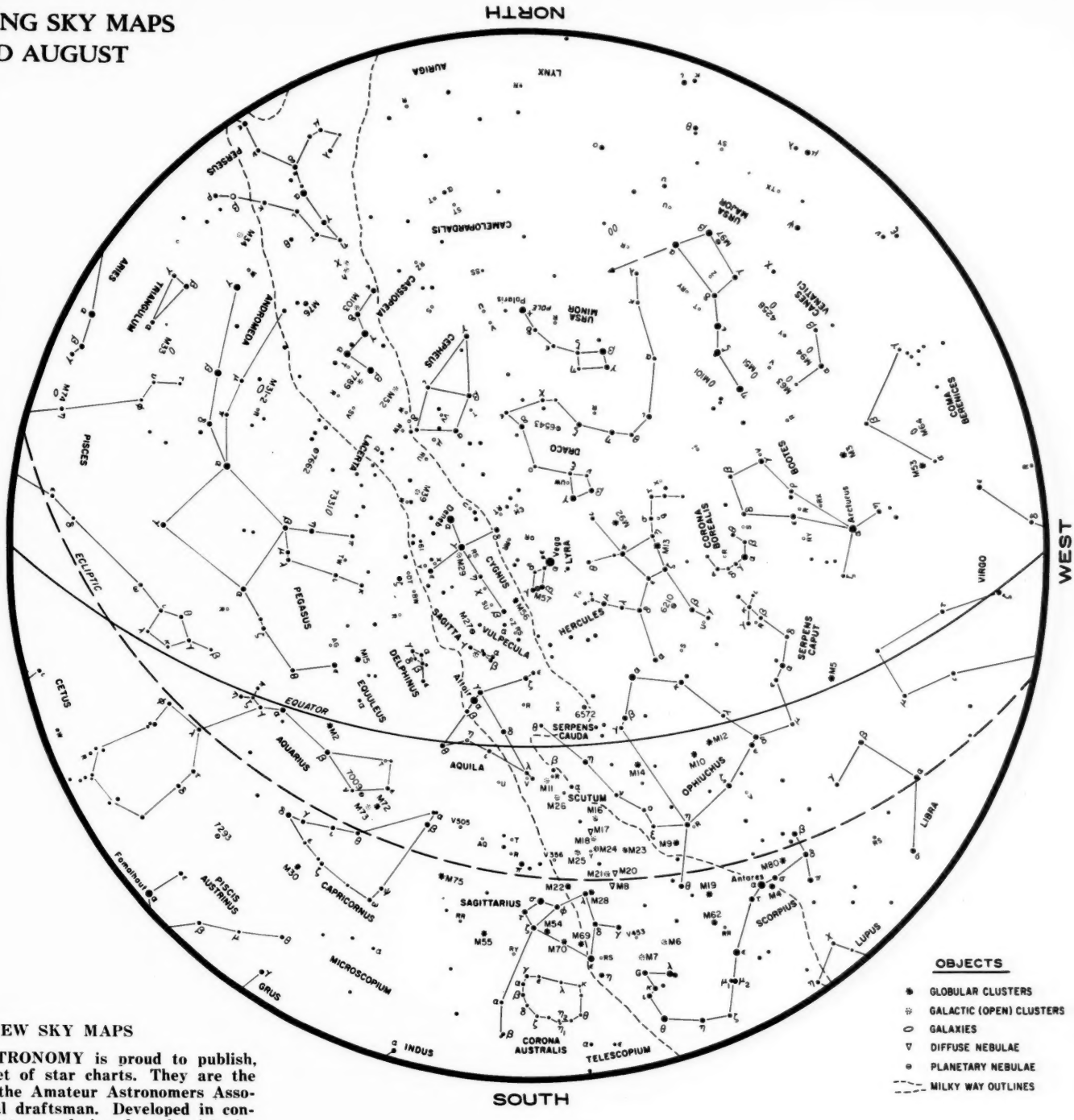
(Local Standard Time)

MONTHLY EVENING
FOR JULY AND

EXPLANATION OF NEW

THE REVIEW OF POPULAR ASTRO
beginning with this issue, a new set
work of George Lovi, a member of the
ciation in New York and a technical d
sultation with the editors, these charts
amateur, in a clear and accurate manner
to the purpose of such a chart. Clutter
ination of unfamiliar star names, righ
circles, constellation boundaries, etc.
stereographic projection, eliminating th
planispheric projection formerly used.
40° north latitude, but are useful 10° no
All stars to magnitude 4.49 are plotted
are all variable stars with maximum b
objects and the more conspicuous NGC

EVENING SKY MAPS
LY AND AUGUST



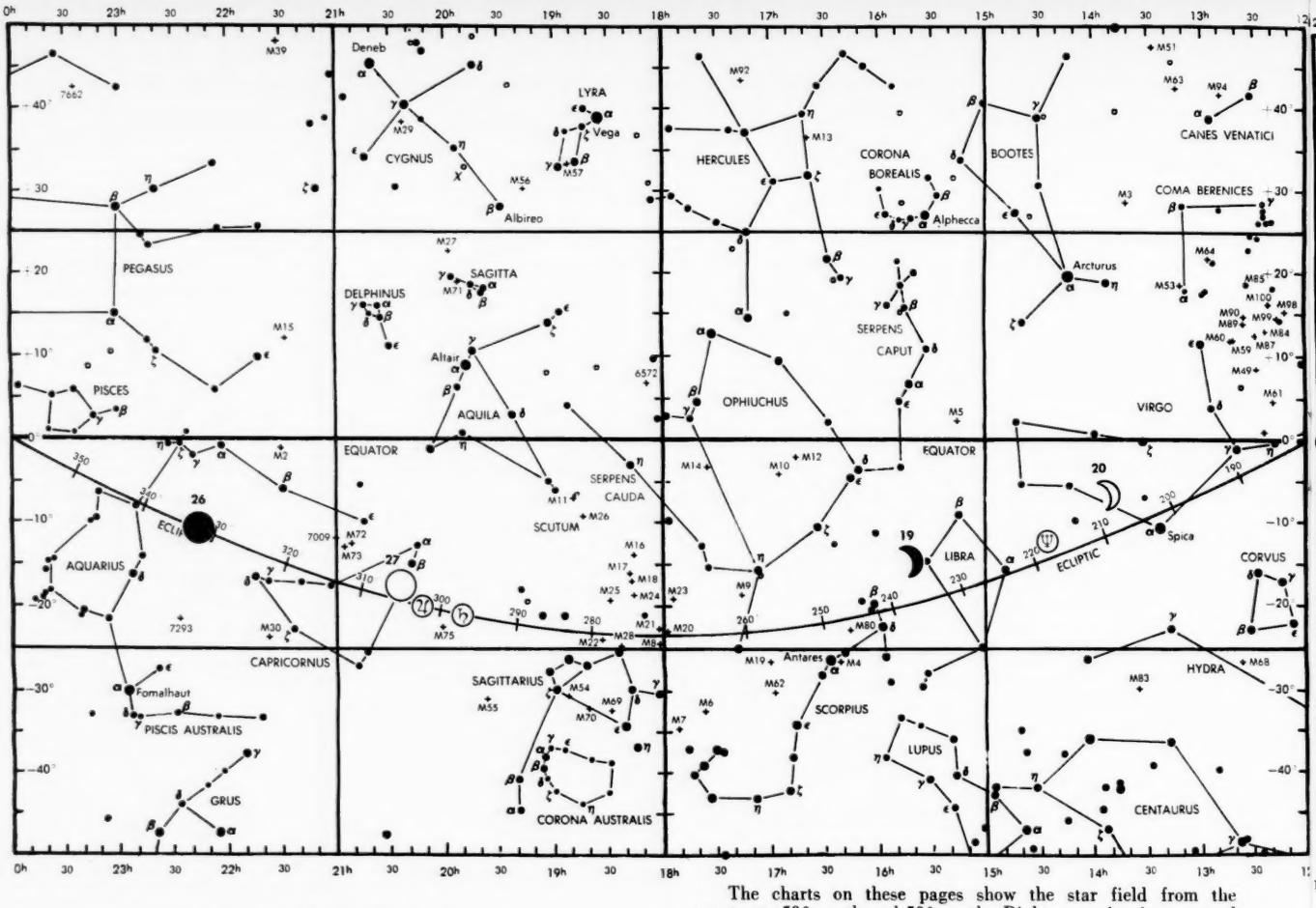
SKY MAP FOR AUGUST

Aug. 1, 10:30 P.M. Aug. 15, 9:30 P.M. Aug. 31, 8:30 P.M.

(Local Standard Time)

ON OF NEW SKY MAPS

LAR ASTRONOMY is proud to publish, a new set of star charts. They are the ember of the Amateur Astronomers Asso- a technical draftsman. Developed in con- these charts are designed to furnish the urate manner, all information appropriate art. Clutter has been minimized by elim- names, right ascension and declination aries, etc. The charts are drawn on a iminating the distortion inherent in the nerly used. The charts are designed for useful 10° north or south of that latitude. are plotted (plus a few fainter stars), as maximum brighter than 7.0, all Messier cuous NGC objects.



EQUATORIAL SKY MAP

The charts on these pages show the star field from the equator to 50° south and 50° north. Right ascension is measured from west to east in hours; each notch at the top and bottom of the charts represents 10m of right ascension. Declination is measured to the north and south of the equator in degrees plus or minus; each notch at the right and left of the chart represents 5° of declination. Longitude along ecliptic is measured in 10° segments.

JULY AND AUGUST AMONG THE PLANETS

SUN: July 1st finds the sun in western Gemini, which it will cross to enter Cancer on the 20th. The sun will enter Leo about August 10th and reach a point 8° east of Regulus at the end of the month. By this time the days will become noticeably shorter and night observing time proportionally longer.

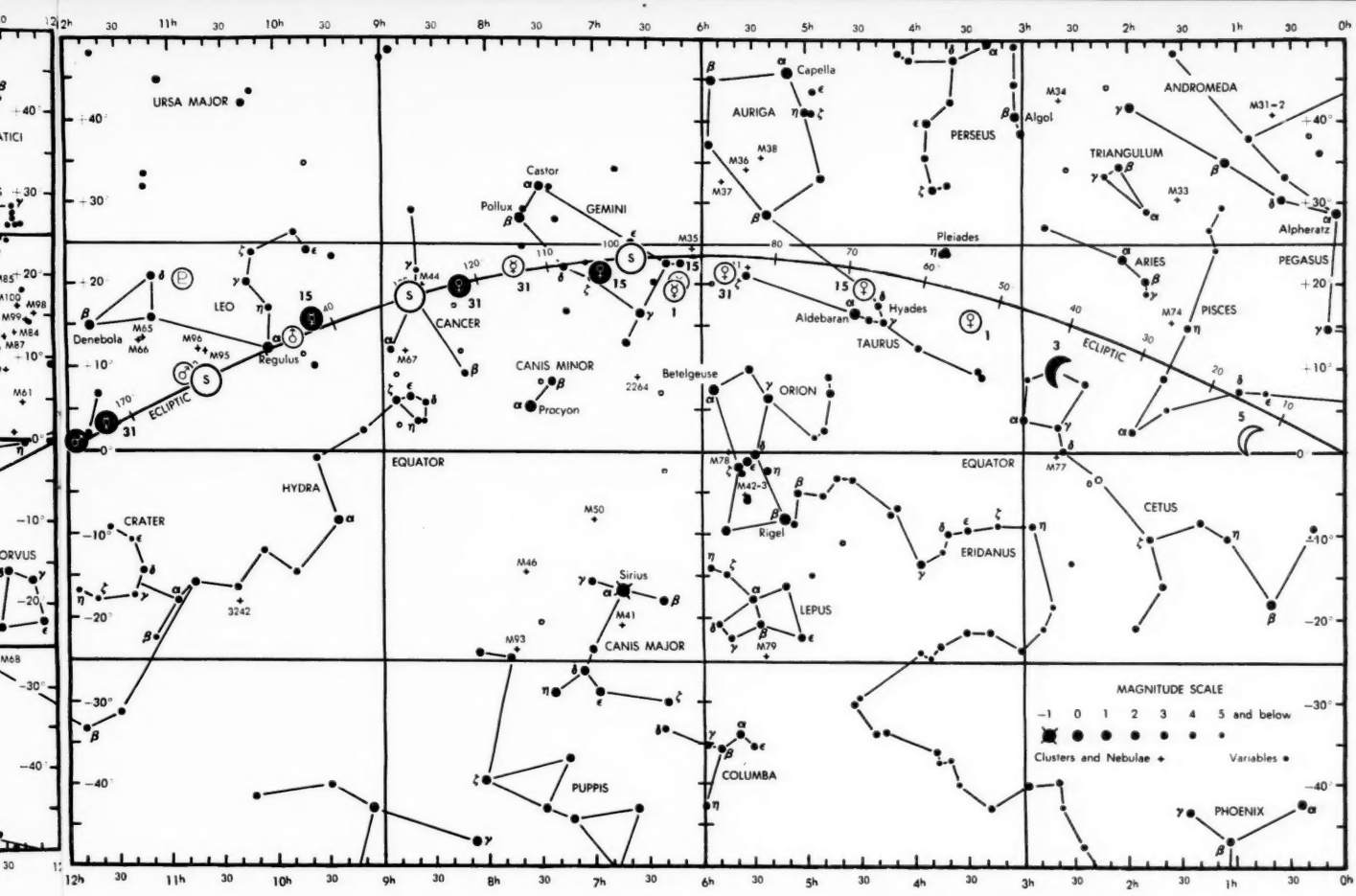
MERCURY: Except for a few days before and after July 19th, when at greatest elongation west, Mercury will be too close to the sun for observation. The slope of the ecliptic to the horizon will be such as to make the 20° elongation rather favorable. The stellar magnitude will increase from 0.4 to –0.7 from 5 days before to five days after elongation. The apparent diameter of Mercury at elongation will be only 8″ of arc.

VENUS: During the entire period of July and August, Venus will be far enough from the sun to permit daylight and twilight observations, and throughout July dark-sky observing will be possible. Advantage should be taken to observe Venus as a morning star, since the morning air is generally steadier than the afternoon and evening atmosphere. This fact should be useful to telescopists seeking better views of Venus. The brightness of the planet will decrease from –3.8 to –3.4 magnitude between July 1st and August 31st.

MARS: The sun is slowly approaching Mars, which can be seen low in the western sky after sunset during July and August. It will move from near Regulus to the middle of Virgo. Its distance from earth increases from 190 to 220 million miles during the period, while its magnitude changes little from 1.8 to 1.9. Telescopically, the disc is between 4″ and 5″ in diameter, too small to be worthy of any real effort.

JUPITER: Views of Jupiter may be had almost any dark hour during the two-month period. On July 25th Jupiter will be in opposition to the sun and visible all night. It has begun its trek northward, but is now retrograding in western Capricornus appears as an exceedingly bright star of –2.3 magnitude. The disc of Jupiter is almost 45″ in diameter.

SATURN: Also in Capricornus a few degrees west of Jupiter, Saturn appears as a 0.3 magnitude star at its opposition on July 19th. It, too, will be retrograding during the entire months of July and August. The long diameter of the rings will be about the same length as the polar diameter



Planets are indicated by standard symbols (see key). White circles for first month; black circles for second month. Moon plotted for exact time of phase (new moon omitted). Mercury and Venus are shown for first, middle and end of months; Mars for middle of month; other planets for mean positions during the two-month period. Sun is shown for first of each month.

KEY TO PLANET SYMBOLS

Mercury	☿	Saturn	♄	First Q. Moon	☽
Venus	♀	Uranus	♅	Full Moon	○
Mars	♂	Neptune	♆	Last Q. Moon	☾
Jupiter	♃	Pluto	P	Sun	s

of Jupiter, while the width of the short axis will be about one third as great as the polar thickness of the planet itself.

URANUS: This planet will be too close to the sun for observation in July and August. It is now close to Regulus in Leo.

NEPTUNE: About 5° west of Alpha Librae, Neptune can be seen only with a telescope or a good pair of binoculars as an 8th magnitude object. Its coordinates are on August 1st: R.A. $14^h\ 27^m$, Dec. −12° 41′.

PLUTO: Now located about 4° west of Delta Leonis, Pluto is invisible except in large telescopes. Its great distance from the ecliptic, which can be noted on the equatorial sky map, is due to the very large inclination of its orbit—about 17°.2.

STUART L. O'BYRNE

SKY WATCHER'S DIARY

JULY

Date	Hour (EST)	Event
4	19	Last quarter
8	14	Mercury stationary
	15	Venus 2° N. of moon
9	06	Aldebaran 0°.4 S. of moon
11	01	Mercury 0°.2 N. of moon
12	15	New moon
15	05	Moon in apogee
	12	Uranus 1° N. of moon
	18	Regulus 0°.3 N. of moon
16	01	Venus 3° N. of moon
	09	Pallas stationary
	21	Mars 0°.3 S. of moon
19	04	Mercury greatest elong. W.
	06	Saturn at opposition
20	18	First quarter
21	04	Neptune stationary
21	12	Neptune 3° S. of moon
25	06	Jupiter at opposition
27	02	Saturn 3° S. of moon
	12	Jupiter 3° S. of moon
	15	Full moon
28	04	Moon in perigee
31	14	Mercury 6° S. of Pollux

AUGUST

Date	Hour (EST)	Event
3	07	Last quarter
5	12	Aldebaran 0°.3 S. of moon
7	13	Venus 3° N. of moon
10	13	Juno stationary
11	06	New moon
	12	Moon in apogee
12	02	Perseid meteor shower
14	10	Mercury in superior conj.
	13	Mars 2° S. of moon
17	19	Neptune 3° S. of moon
19	04	Uranus in conj. with sun
	06	First quarter
23	10	Saturn 3° S. of moon
	18	Jupiter 3° S. of moon
24	06	Venus 7° S. of Pollux
25	14	Moon in perigee
	22	Full moon (eclipse)
31	08	Pluto in conj. with sun

(In areas using daylight saving time observers can convert by using the standard time of the zone to their east—for example, CDT = EST, PDT = MST, etc.)

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Moon at 16 days, showing limb in vicinity of Petavius, Oct. 28, 1958, as photographed by Carlos E. Rost of Pan American College Observatory, Edinburg, Texas. Made with 6-inch catadioptric Fecker reflector, using 270x eyepiece projection and exposure of 5 seconds on Plus-X film.

OUTER SPACE PHOTOGRAPHY

By HENRY E. PAUL

LENS SYSTEMS FOR ASTROPHOTOGRAPHY

IN THE MAY-JUNE ISSUE we discussed the adaptability and availability of various types of camera lenses for astrophotography. Let us now review briefly the *lens systems* most useful to the amateur in astrophotography. Such "optical trains" are actually quite simple to assemble, consisting of a main light-collecting lens (or mirror), intermediate lenses (such as your camera lens and/or eyepiece) and a camera box. The accompanying diagram illustrates in a diagrammatic manner four of the more common optical lens systems using an ordinary achromatic long-focus refractor telescope lens as the primary light collector. However, the mirror of a reflecting telescope could serve the same purpose in collecting light as does the objective lens illustrated here. All systems as presented have the same equivalent focal length and produce the same image size, but are not to scale.

(a) Illustrates the simplest telescopic lens setup. A 35mm reflex camera without lens completes this arrangement. This photographic setup is particularly desirable for use with telescopic-type lenses or mirrors having focal lengths of 50 inches or longer. One of 90 inches focal length produces an ideal-sized image of the moon on a 35mm frame. One of the advantages of this system is that no light is lost or scattered by extra lenses in the system, nor are the aberrations of added lenses (unavoidable even in the best of lenses or eyepieces) present to detract slightly from final image sharpness. The over-all simplicity of this system speaks for itself.

(b) Here is shown a common method of coupling a camera with its lens directly to the eyepiece of a complete telescope. This system is particularly applicable for use with shorter focal length telescopes as rifle-range spotting scopes, or with one half of a binocular, to increase the image size on your film (over what your camera lens would give alone) by the magnification of the instrument—as indicated on the eyepiece for that instrument. Higher magnification eyepieces (shorter focal lengths) will give proportionately larger images on the film. Longer focal length camera lenses may also be used to increase the image size; of course, the converse in each case reduces the image size. The camera and telescope must be focused at infinity—the latter requirement needs special consideration.

(c) The so-called projection meth-

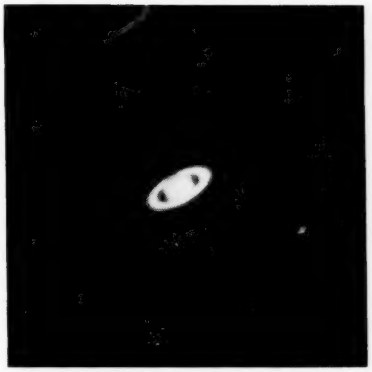
Dr. Henry E. Paul is an amateur of broad experience and wide acquaintance in the fields of astronomical photography and telescope optics. Besides his several chapters in AMATEUR TELESCOPE MAKING (ADVANCED), *Dr. Paul is the author of the recently published book,* OUTER SPACE PHOTOGRAPHY, A *Amphoto, New York, 1960: $2.50. His column in this issue is based on the first chapter of that book, with permission of the publisher. He will continue to conduct and contribute to this feature in future issues.*

od, as illustrated, requires a camera to be coupled without its lens and so arranged that the projection eyepiece and camera can be "racked out" until an image falls in focus at the focal plane of the camera. The image on the film is increased in size as the distance between the eyepiece and the film increasse, and additionally by the use of shorter focal length (higher power) eyepieces or lenses. These two variables may be juggled about by trial and error to obtain what you desire as to image size [or calculated by formulas in appendix of Dr. Paul's book, *Outer Space Photography*]—then make final fine adjustments. Orthoscopic eyepieces are recommended.

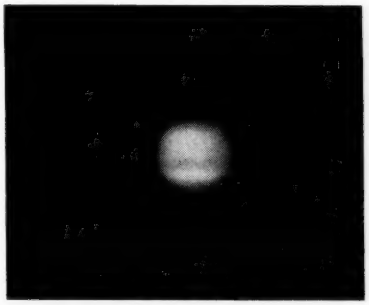
(d) Often overlooked but having considerable merit, simplicity, and flexibility is the use of a negative achromatic (Barlow) lens as shown in the adjacent illustration. This negative lens (concave side toward camera) is placed just inside the normal focus of the telescope lens, and as it is moved in toward the objective, the resulting image moves farther back and at the same time increases in size. For use with the 35mm reflex camera, such Barlows should be about 1 inch in diameter and from 3 to 6 inches in negative focal length (as available) for ordinary refracting-type telescopes (1½ to 4 inches negative focus for reflecting-type telescopes). These longer focal length Barlows will in general perform better in photography.

Since three of these four systems use no regular camera lenses, the so-called "camera" could be only a box-type film holder. My first high-speed setup for nebula photographs (7-inch f/2.8 Zeiss Sonnar) simply utilized the ground-glass focus-checking units as a round plate holder. Nevertheless, the modern single-lens reflex camera without lens provides a much more convenient means of obtaining sharp focus.

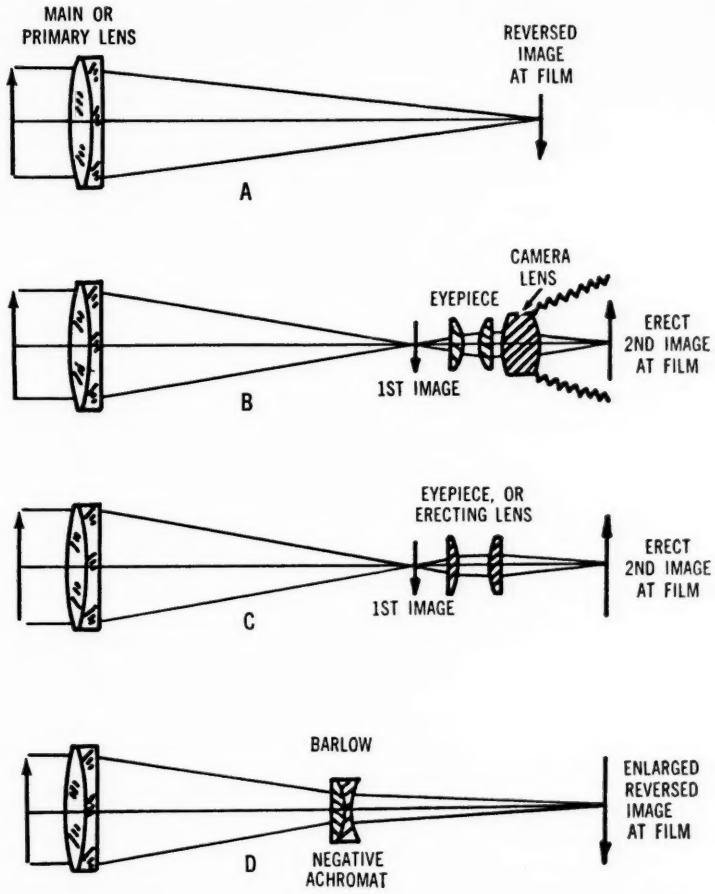
The usual amateur reflecting telescope from 6 to 12 inches in aperture and focal lengths from 48 to 90 inches is quite adaptable for use with the image falling directly on the film. The resultant moon or sun image—



Saturn at prime focus of 6-inch Fecker reflector using 5x amplifying system, also by Fecker. Photo by Rost.



Finer detail on this photo of Jupiter — including barely visible shadow of satellite Ganymede north (lower) polar region. Photographed by Rost using name system as with Saturn.



with a diameter of from 4/10-8/10 of an inch—when taken on a fine-grain film such as Eastman's Microfile may be enlarged to almost any desired size. It is convenient to approximate the image diameter of the sun or moon 1/100 that of the focal length (in inches).

Each method described has its advantages (and limitations) for certain areas of astronomical photography. Many areas, such as solar, lunar and star-field photography, are "naturals" for standard photographic equipment. Others, such as photography of planets and faint distant nebulae, can challenge even the well-equipped, experienced amateur.

Four lens systems most commonly used in astrophotography. Same set-ups would apply for reflecting telescopes. (Drawing reproduced from "Outer Space Photography" by permission of author and publishers.)

HOW TO USE THESE OCCULTATION PREDICTIONS

Predictions are made by H. M. Nautical Almanac Office for 12 stations in the United States and Canada. Some of these stations actually lie within certain large cities, but others are merely selected for geographical location and do not coincide with specific cities. Unless you live within a few miles of the points designated by longitude and latitude coordinates of one of these standard stations, correction must be made to the times given in the above list.

First, the longitude and latitude of the nearest standard station must be subtracted from your own longitude and latitude. If you are north of the standard-station latitude or north of the standard-station longitude, the sum will carry a minus sign. The difference in longitude is then multiplied by the longitude correction figure given in the tables for your standard station; likewise for the latitude correction. These two quantities are then added, being careful throughout to take into account the plus and minus signs. The sum of these two numbers will be your corrected factor for that occultation, and is subtracted or added, as the signs demand, from the listed time of occultation. These times are only a guide, however, and you should be prepared to begin observations a few minutes in advance of the predicted time.

Occulted stars are designated in most cases by constellation and appropriate Greek letter designation or Flamsteed number. In some cases the *Bonner Durchmusterung* catalog number (e.g. 57° 485) is used for fainter stars. Only stars brighter than 5.0 are published in this selected list. Complete predictions of all observable occultations are published in advance for each year in the December issue of SKY AND TELESCOPE magazine.

The column under "Phenomenon" shows whether the occultation is a disappearance (D), a reappearance (R), or a grazing occultation (G), which may or may not occur for a particular station. Age of the moon is given in days from new moon, and the position angle on the limb of the moon is given in degrees. Position angle is measured eastward from north; orientation can be determined by letting the moon drift through the field of view to establish the east-west axis. Be certain to allow for inversion by the telescope: in a normal situation, looking generally southward from the zenith, north (0°) will be toward the bottom of the field; south (180°) at the top; east (90°) at the right; and west (270°) at the left.

Observations should be sent, as soon after the end of the year as possible, to H. M. Nautical Almanac Office, Royal Greenwich Observatory, Herstmonceux Castle, Hailsham, Sussex, England.

Station & Location	Long.	Lat.
A (Massachusetts)	72°.5	42°.5
B (Montreal)	73°.6	45°.5
C (Washington, D. C.)	77°.1	38°.9
D (Toronto)	79°.4	43°.7
F (Illinois)	91°.0	40°.0
G (Texas)	98°.0	31°.0
H (Denver)	105°.0	39°.7
I (New Mexico-Arizona)	109°.0	34°.0
J (Edmonton, Alta.)	113°.1	53°.5
K (California)	120°.0	36°.9
L (Oregon)	121°.0	32°.5
M (Vancouver, B. C.)	123°.1	49°.5

LUNAR OCCULTATION PREDICTIONS — July-August 1961

Sta.	Date	Name & Number	Mag.	Phen.	Age of Moon	(EST) Time	Correction Long.	Correction Lat.	Position Angle
A	July 9	Alpha Tauri 692	1.1	D	26	04:42.7	+0.3	+3.2	22°
				R	26	05:25.0	−1.5	+0.1	304°
	July 23	24 Scorpii 2399	5.0	D	11	23:45.3	−0.9	−0.3	55°
	Aug. 4	5 Tauri 508	4.3	D	23	05:08.0	−1.7	+0.8	95°
	Aug. 5	Gamma Tauri 635	3.9	D	24	02:34.7	−0.1	+2.3	46°
				R	24	03:35.2	−1.1	+1.1	278°
B	July 9	Alpha Tauri 692	1.1	D	26	04:53.8	.....	.....	9°
				R	26	05:22.3	.....	.....	318°
	July 23	24 Scorpii 2399	5.0	D	11	23:43.7	−0.8	−0.1	47°
	Aug. 5	Gamma Tauri 635	3.9	D	24	02:41.8	0.0	+2.5	38°
				R	24	03:36.9	−1.2	+0.9	287°
C	July 9	Alpha Tauri 692	1.1	D	26	04:33.1	+0.3	+2.8	27°
				R	26	05:18.1	−1.2	+0.3	299°
	July 23	24 Scorpii 2399	5.0	D	11	23:41.7	−1.2	−0.3	61°
	Aug. 4	5 Tauri 508	4.3	D	23	03:57.4	−1.7	+0.8	99°
	Aug. 5	Gamma Tauri 635	3.9	D	24	02:26.5	0.0	+2.1	49°
				R	24	03:26.5	−0.9	+1.1	275°
D	July 9	Alpha Tauri 692	1.1	D	26	04:50.7	.....	.....	5°
				R	26	05:13.4	.....	.....	323°
	July 23	24 Scorpii 2399	5.0	D	11	23:38.5	−1.1	+0.1	48°
	Aug. 4	5 Tauri 508	4.3	D	23	03:59.3	−1.2	+1.4	84°
	Aug. 5	Gamma Tauri 635	3.9	D	24	02:37.4	+0.1	+2.4	36°
				R	24	03:29.0	−1.0	+0.9	289°
F	July 9	Alpha Tauri 692	1.1	D	23	04:47.9	.....	.....	355°
				R	23	04:58.2	.....	.....	335°
	July 23	24 Scorpii 2399	5.0	D	11	23:21.2	−1.8	+0.3	55°
	Aug. 4	5 Tauri 508	9.3	D	23	03:42.3	−0.8	+1.5	79°
				R	23	04:52.1	−1.0	+2.0	237°
	Aug. 5	Gamma Tauri 635	3.9	D	24	02:31.7	+0.4	+2.3	33°
				R	24	03:16.9	−0.6	+0.7	294°
	Aug. 24	Rho Capricorni 2987	5.0	D	13	02:44.4	−1.5	−2.1	118°
G	July 9	Alpha Tauri 692	1.1	R	26	05:00.1	−0.4	0.0	302°
	July 23	24 Scorpii 2399	5.0	D	11	23:05.1	−2.4	0.0	79°
	Aug. 4	5 Tauri 508	4.3	D	23	03:25.8	−0.6	+1.0	93°
				R	23	04:26.9	−0.5	+2.3	224°
	Aug. 5	Gamma Tauri 639	3.9	R	24	03:07.4	−0.1	+0.8	277°
H	July 23	24 Scorpii 2399	5.0	D	11	22:51.5	−2.3	+0.7	62°
	Aug. 4	5 Tauri 508	4.3	D	23	03:35.0	−0.2	+1.7	67°
				R	23	04:39.4	−0.7	+1.7	252°
	Aug. 24	Rho Capricorni 2987	5.0	D	13	02:22.7	−1.7	−1.1	99°
I	July 23	24 Scorpii 2399	5.0	D	11	22:38.4	−2.5	+0.4	79°
	Aug. 4	5 Tauri 508	4.3	D	23	03:25.6	−0.1	+1.4	76°
				R	23	04:27.2	−0.4	+1.7	244°
	Aug. 5	Theta[1] Tauri 669	4.0	D	24	06:43.3	−1.8	+0.4	106°
	Aug. 24	Rho Capricorni 2987	5.0	D	13	02:31.5	−2.2	−1.4	110°
J	July 23	24 Scorpii 2399	5.0	D	11	22:51.5	.....	.....	31°
	Aug. 4	5 Tauri 508	4.3	D	23	04:02.6	+0.1	+2.3	37°
				R	23	04:53.8	−0.7	+1.3	285°
	Aug. 24	Rho Capricorni 2987	5.0	D	13	02:04.0	−1.1	−0.2	65°
K	July 2	Sigma Aquarius 3307	4.9	R	19	05:41.1	−2.3	0.0	271°
	July 23	24 Scorpii 2399	5.0	D	11	22:13.9	−2.1	+0.7	86°
	Aug. 3	Mu Ceti 405	4.4	D	22	05:46.0	−1.5	+1.7	64°
	Aug. 4	5 Tauri 508	4.3	R	23	04:26.5	−0.2	+1.4	258°
	Aug. 5	71 Tauri 661	4.6	R	24	05:58.8	+0.6	+4.0	191°
	Aug. 5	Theta[1] Tauri 669	4.0	D	24	06:30.8	−0.9	+1.3	86°
				R	24	06:42.1	−1.1	+2.1	237°
	Aug. 5	Theta[2] Tauri 671	3.6	D	24	05:35.8	−1.3	+0.5	109°
				R	24	06:33.7	−0.6	+3.0	213°
	Aug. 24	Rho Capricorni 2987	5.0	D	13	01:56.3	−2.1	−0.3	91°
L	Aug. 3	Mu Ceti 405	4.4	D	22	06:56.9	−1.1	+2.1	48°
	Aug. 4	5 Tauri 508	4.3	R	23	04:35.0	−0.4	+1.3	272°
	Aug. 5	71 Tauri 661	4.6	R	24	05:19.6	−0.1	+2.7	215°
	Aug. 5	Theta Tauri 669	4.0	D	24	06:40.3	−0.7	+1.8	70°
	Aug. 5	Theta[2] Tauri 671	3.6	D	24	06:41.0	−0.9	+1.3	91°
	Aug. 24	Rho Capricorni 2987	5.0	D	13	01:53.7	−1.7	0.0	77°
M	Aug. 4	5 Tauri 508	4.3	D	23	03:55.1	+0.2	+2.2	37°
				R	23	04:43.0	−0.4	+1.2	287°
	Aug. 5	71 Tauri 661	4.6	R	24	06:35.9	−0.3	+2.2	233°
	Aug. 5	31 Tauri 669	4.0	D	24	06:53.3	−0.4	+2.2	53°
	Aug. 5	Theta[2] Tauri 671	3.6	D	24	06:50.4	−0.6	+1.8	74°
	Aug. 24	Rho Capricorni 2987	5.0	D	13	01:51.5	+1.4	+0.3	64°

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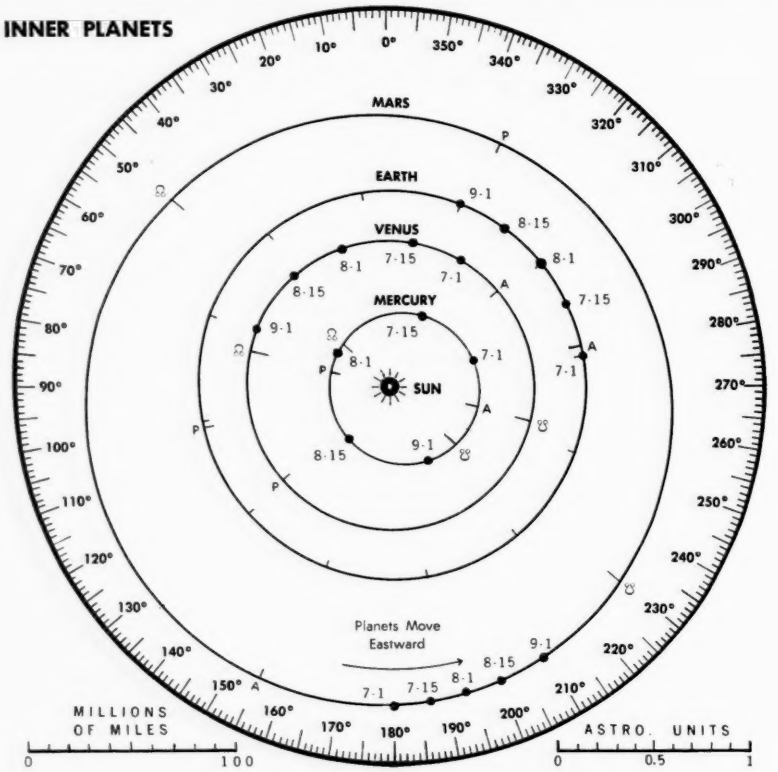
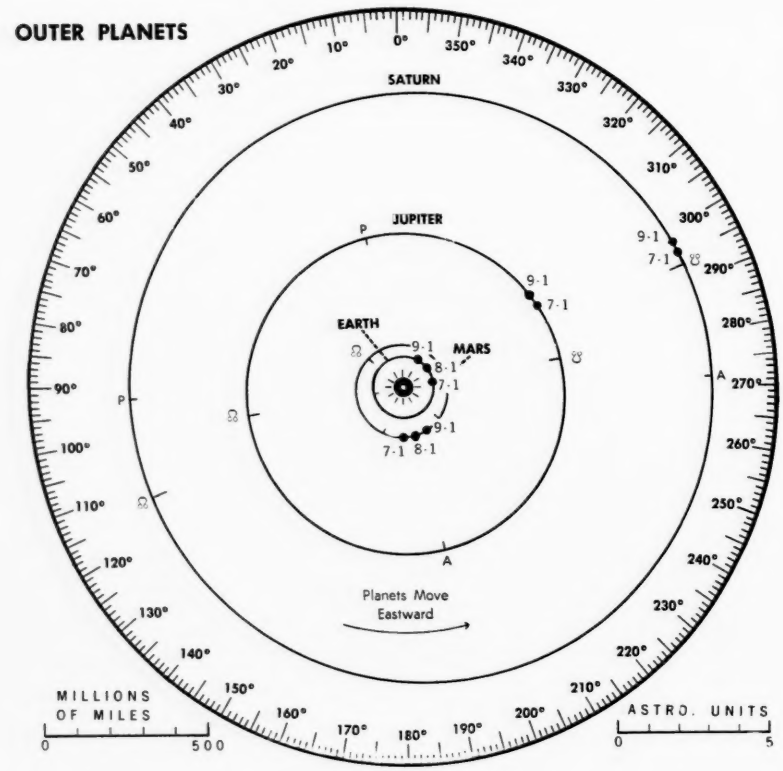
Heliocentric Planet Charts for July and August





Presented here are two new charts intended to show the heliocentric and geocentric movements and positions of the naked-eye planets. The upper indicates the orbits of the "terrestrial" planets—Mercury, Venus, earth and Mars—and the lower chart shows the orbits of Jupiter and Saturn, with those of Mars and earth for reference. The orbital positions of the inner planets are shown for the 1st and 15th of each month, from July through Sept. 1st, 1961. The positions of Jupiter and Saturn are shown only for July 1st and Sept. 1st, as their motions are relatively slow. Orbits are to scale.

Scales of distance in astronomical units (mean distance from earth to sun: 92,900,000 miles) and millions of miles are included for each chart, and can be used to measure approximate distances between any pair of planets, or planets and the sun. The nodes are indicated so that one may determine upon which side of the ecliptic, north or south, a planet will be found. Moving eastward, a planet, having crossed the ascending node (☊), will be *north* of the ecliptic, until it reaches the descending node (☋), when it crosses to the *south* until it passes the ascending node again. Positions of perihelion (P) and aphelion (A)—closest and farthest distance from the sun—are indicated by the appropriate letter and a long tick.

Progress of the planetary rhythms can be followed with considerable exactitude from month to month. Their configurations — conjunctions, oppositions, elongations, passages of perihelia, for example — should be easily noted. The interested reader will discover much other useful information that can be gleaned from study of this regular new feature.

Heliocentric and Geocentric Longitudes

The heliocentric longitude (i.e., as seen from *sun*) of a planet at any time can be read from the charts by drawing a straight line from the center of the sun through the planet and intersecting the outer scale of longitude at the required point. Dates between those indicated for any planet can be interpolated, or estimated.

An example of this simple and useful calculation can be found on page 24 of the March-April issue.

BRIGHT-SKY OBSERVING WITH SMALL TELESCOPES

It always is upsetting to think that most persons feel a three-inch telescope is the smallest one should buy to enjoy the sky. I possess a 60mm (that's a little under 2½ inches) Bausch and Lomb spotting scope and do amazing things with it.

In the early evening I always test the sky by picking up Polaris (the North Star), a double of 9th magnitude which, in many books, is considered difficult for a three-inch scope. Eleventh magnitude stars are not difficult in a clear and moonless sky, and 4″ doubles such as Gamma Leonis are routine. With an added Barlow lens I have seen Castor double many times, as well as Epsilon Lyrae. I have separated Struve 795 Orionis, listed at 1.5″ of arc, and if doubles are not too bright, 2″ of arc is none too difficult. (The theoretical limit is 2.1″ of arc.)

I'm convinced that some observers see more with the naked eye than others with binoculars, and some see more in binoculars than others see with telescopes. All it takes is a clear sky and determination—which should not be confused with imagination.

Observing just for the sake of observation has been a hobby of mine for several years. It may be foolish but I have systematically searched for stars by day using the same 60x, 60mm B and L spotting scope, and to date have seen some 47 stars in the daylight hours. A star has a most unusual look by day, showingfi a pin-like brightness lacking all twinkle. I mention this hobby of picking up stars by day because if others try I'm certain they'll find it great sport too. I'll never forget the morning I spotted Polaris (2.12 magnitude) two hours after sun-up.

As I say, it may be a foolish pastime but it's fascinating and extremely difficult, especially without setting circles. I use two methods—either having the star spotted the night before, just after sundown, or finding the star by using a bright object such as the moon, sun, Venus, Jupiter, and sometimes Mars, when close to the earth, since it too is fairly bright in daytime. I spotted Saturn only 15 minutes before sundown using only 6x35 binoculars, but it is a difficult object. For example I saw Spica in broad daylight 4° below Venus; Aldebaran 11′ of arc west of the moon 26 minutes before sundown and Pollux three minutes before sundown, using only 15X.

But, for the novice daylight stargazer, I'd suggest picking up the bright planets by day, using 7x50 binoculars, although I've seen them with 6x35.

Josef R. Otoupalik, D.D.S.
Greeley, Colorado

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Author Cave poses with long-focus 12" reflector which he made in 1948 for planetary observing. Note convenient rotating tube at eyepiece end, yoke mounting and efficient observing stand.

YOUR TELESCOPE AND MINE

By Tom Cave

LONG-FOCUS REFLECTORS

Probably the most exciting objects in the entire heavens to many amateur telescopists are the moon, Jupiter, Saturn and Mars. The first object usually examined by the novice is the moon, and even a very small telescope will show an enormous amount of most interesting detail. A good two- or three-inch refractor with a low-power eyepiece will easily show the four Galilean satellites of Jupiter, while a power of 100 to 130 will reveal the two most prominent Jovian belts and even the Great Red Spot during apparitions of the planet when it is most obvious. Ringed Saturn, although always a thrilling sight, is seen with much less detail than Jupiter in a very small telescope. On Mars some of the main dark *maria* and polar caps may be seen during a favorable opposition, but a very small telescope leaves much to be desired in its ability to give more than the most general views of the planets.

Many amateurs, however, after their first complete tour of the heavens with a small telescope, have a real desire to view in far greater detail the fascinating surfaces of the planets. It soon becomes obvious after further reading that a very large part of visual planetary research work by famous observers over the last century has been accomplished with telescopes from 8-20 inch aperture (the average aperture of these was just under 11 inches).

Besides moderate aperture, three things are absolutely essential for serious planetary observing. They are: one, as near-perfect optics as possible; two, good to excellent "seeing" conditions; and three, a patient and persistent observer.

First, the telescope itself should preferably be at least ten inches in aperture, either reflector or refractor. Most amateurs must rule out the refractor of this size due to cost. If the ten-inch telescope is a reflector, a simple Newtonian of long focus will give the best performance and will be the least expensive to construct or purchase. In a ten inch, a focal ratio of f/10 or f/11 (100"-110") will be easiest to figure if the amateur undertakes the optical work.

A much greater allowable optical tolerance is permissible on a ten-inch f/10 to f/12 than on the more conventional focal ratios of f/6 to f/8. The longer focal ratio also permits a a s m a l l e r diagonal; actually, a high-quality diagonal flat of only 1-1½ inches minor axis is amply large at f/10 to f/12.

A double-yoke type of mounting is perhaps the best choice for a reflector of very long focus. This type of mounting may be more easily fabricated by the amateur and at much less cost than most other forms of equatorial mountings. A ten-inch long-focus reflector should, of course, be permanently mounted if at all feasible, and since the telescope is primarily intended for optimum lunar, planetary and perhaps double-star observation, setting circles can be eliminated. While a focal ratio of f/6 to f/8 is usually designed for all types of general visual observing (plus perhaps stellar photography), a truly long-focus reflector is intended primarily for high-resolution observing and short-exposure photography of the moon and planets. A simple clock drive will prove entirely adequate for this planetary telescope, if well balanced.

The long-focus reflector does present one problem—that of easy access to the eyepiece. Some form of ladder will, of course, bring the observer in a standing position to the eyepiece, but such an arrangement is far from being convenient or comfortable. In order to do serious planetary observing, the observer should be seated at all times at the eyepiece, and both his hands should be free for sketching or making notes on observations. Therefore, some form of elevated platform or bridge can be easily constructed so that the observer may sit at the eyepiece. If the zenith height of the eyepiece of the ten-inch f/10 scope is to be 8 feet, then the elevated platform should be 5 feet above the ground. A sturdy box having three different dimensions will serve well as a seat for the observer.

If at all possible, some form of sturdy rotating tube saddle should be made so the eyepiece may be kept in a convenient and nearly horizontal position, regardless of the section of the sky to which the telescope is pointed. This last convenience can-

This photograph of partial phase of total lunar eclipse of Sept. 5, 1960, was made with an Exa camera attached to an 8-inch telescope. It was made by reader G. A. T. Heillegger, an amateur astronomer and assistant director of Radio Caribe in Willemstad, Curacao.

NEARLY TOTAL ECLIPSE OF MOON IN AUGUST

A lunar eclipse which, for all practical purpose will be total (0.99), will be generally observable across most of North America on the evening of Aug. 25th. The eclipse will begin at 8:35 p.m. (EST), with mid-eclipse occurring at 10:08 p.m. The moon leaves the dark umbra of the earth's shadow at 11:42 p.m. (EST). Most of the eclipse will take place in twilight hours on the West Coast, however. This eclipse is one in a series which began in 1835 and which will not become total until 1979.

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not be overemphasized and may not always be apparent until the observer has suffered the experience of trying to make observations while looking up at the eyepiece at a 40-50° angle. The troublesome floating "motes" within the eye are always minimized when the observer's head is in a horizontal position.

The optical figure of this long-focus ten-inch reflector must be good; however, the great tolerance of allowable aberration in a long-focus mirror is a great help to the amateur optician. The mirror of even a ten-inch f/12 should be very slightly parabolized, but even an f/10 is much closer to a spherical correction than the shorter-focal-length mirrors. The cost of building a ten-inch f/10 to f/12 Newtonian, even if the optics are purchased rather than homemade, will normally not exceed a few hundred dollars, provided the mounting is kept simple in design and is made from readily obtainable materials such as hardwood, surplus or scrap metals, etc. The diameter of the telescope tube should be about two inches larger than the mirror, and the tube should be made of wood, inch f/6 Newtonian, on nights of excellent seeing, will give definition and resolution equal to the best 12-inch refractor. The greater ease of fiberglass, or other non-conducting type of material.

However, it should be mentioned that, if the optics are of absolutely the highest quality, a Newtonian reflector of f/6 or f/7 will perform equally as well as a long-focus reflector; the writer's personal 12½-figuring the long-focus mirror and the larger tolerance for error in correction make this mirror well suited for the amateur mirror maker.

The amateur astronomer who builds a ten-inch long-focus reflector with these characteristics will discover the truly amazing performance rendered by his telescope on exceedingly fine lunar and planetary detail, and the star images under high powers and good seeing will be a source of endless delight.

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This economical equatorial mounting for small telescopes was designed and constructed by James F. Ardery, and incorporates the use of epoxy resin as bearings instead of babbitt metal or other materials. All photographs by the author.

HOW TO MAKE

A $25 Equatorial Mounting For Your Telescope

THE REALISTIC EXPENSE of mounting a small telescope is seldom reflected by the figure quoted in books on telescope making, as material costs have increased since these publications were first introduced. However, I successfully designed an equatorial mounting for my 4¼-inch telescope that is close to the old prices, my total expenditure amounting to $25.10. This was a first venture into instrument making, my interest in astronomy being only a year old. The pleasure afforded during this period from study of this fascinating science has been a most rewarding experience.

The mounting is assembled by casting 6″-long brass tubing inside pipe fittings using the new epoxy resin and lapping the steel shafting into a fit with the tubing. Then, using the flanges and bushings, the parts are put together. The photographs and diagram show the principal constructional details and the accompanying list indicates the various parts and their cost.

A method of aligning the brass sleeves inside the pipe fitting "Y" (polar axis) and "T" (declination axis) must be provided. A method similar to that outlined by Allyn Thompson in his book, *Making Your Own Telescope*, is very satisfactory. Drill and tap three holes near the opposite ends of the fittings just inside the flange and spaced 120° apart. Either 6-32 or 8-32 taps should do.

To assure a good bond and eliminate any possibility of the bearing sleeves turning in the epoxy, a coil of about six turns of No. 14 soft-drawn copper wire was soldered around each one. If one does not have a soldering iron this can be done on the low heat of an electric stove.

The only machining and welding required was on the shafting and bushings. The bushings were machined out to 1-3/16″ and the steel shafting inserted until the end was just below the top of the threaded portion; then it was welded into place. By limiting the weld to the outside end of the unit only, it will not be necessary to do any more machining to remove excess weld.

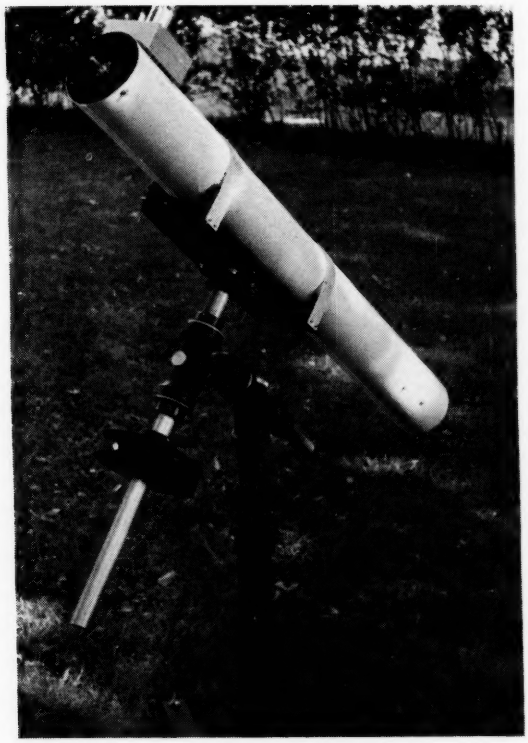
Place one of the 6″ brass sleeves in the "Y" and, using the sets of three adjusting screws at each end, approximately center the tubing in the fitting. Now securely clamp the fitting in a vise and using a level adjust it until it's exactly horizontal. Carefully insert the polar axis into the brass sleeve and use the level on the extend portion of the shaft to adjust the six screws until the axle is horizontal. Rotate the fitting 90° in the vise and repeat the procedure. It will be necessary to go back and forth between settings a number of times before the polar axle is perfectly centered.

It is necessary to make seals to place around the ends of the axle to close the end and retain the epoxy. If temporary, cardboard, fiberboard, Masonite, or a similar material can be used. I made mine of scraps of 1/16″ aluminum, their inner diameter being equal to that of the sleeve and the outside matching the diameter of the flange ends of the fitting. Temporary seals can be taped in place, but my aluminum pieces were drilled with three clearance holes in fabricating and these holes located the position of three holes drilled and tapped in the pipe fitting when the centering was complete. This made them a permanent part of the mounting.

Screw the side opening of the "T" into the bushing that is welded to the north end of the polar axle and swing the "Y" fitting until it is perpendicular in the vise. Approximately center the brass sleeve in the declination "T" and insert the 2-foot axle. Adjust until the shaft is exactly level taking care that the location of the sleeve in the "Y" is not disturbed. Gently remove the declination axle, after first sealing the ends in a manner similar to that of the first pipe fitting. Unscrew the "T" from the polar axle and remove this shaft from its assembly.

With putty or a suitable caulking compound carefully seal any cracks

(Continued on page 32)

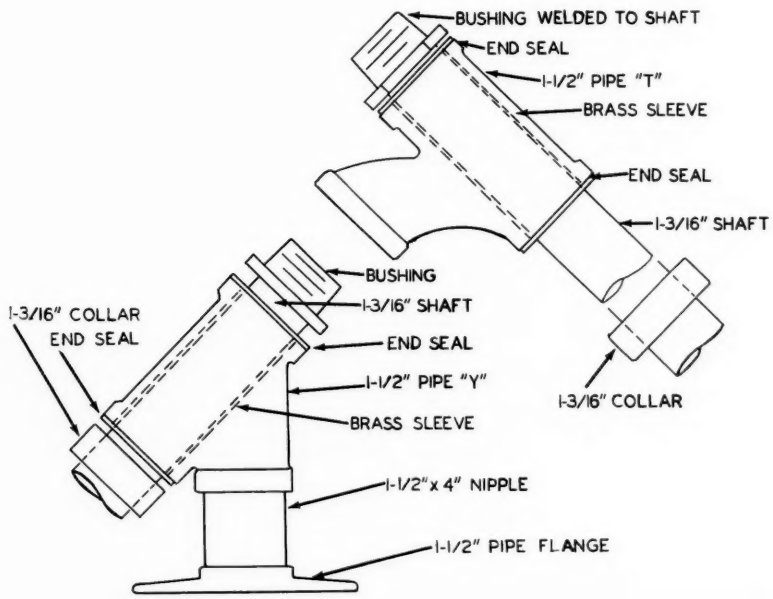


This full view of Ardery mounting and 6-inch reflector shows overall design. Declination axis (joining saddle) is probably longer than necessary, and offset "T" is not a requirement.

DIAGRAM AND LIST OF PARTS FOR MOUNTING

Quantity	Approx. cost
3 1½" pipe flanges @ 90c	$2.70
1 1½" pipe, drainage "T"	1.20
1 1½" pipe, drainage "Y"	1.20
3 1 3/16" cold rolled steel shaft	3.00
1 1½" x 4" pipe nipple	.50
2 ¾" x 1½" pipe bushings @ 60c	1.20
2 1 3/16" shaft collars @ 1.00	2.00
1 iron pulley counterweight from junk yard—wt. 8 lbs.	.80
1 quantity misc. assorted hardware	1.00
1 qt. casting epoxy and hardener	5.00
1 machining and welding	2.50
2 6" pieces brass tubing, 1 3/16" ID @ 50c	1.00
TOTAL	$22.10

(Additional parts for the base and stand were purchased from a junkyard for under $3.00. This brings total cost to $25.10.)



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QUALITY OPTICS
Prof. Harold E. Snyder
1000 W. McKinley Ave., Mishawaka, Ind.

(Continued from page 30)

between the brass sleeves and the end seals and the pipe fittings and the seals.

Place the two fittings so the base of the "Y" and the opening in the "T" that screws onto the polar axle are upright and, using the level, block and shim until they are horizontal. Be sure they cannot turn during the pouring of the epoxy.

The epoxy used was one that cured at room temperature and which flowed readily when mixed, as opposed to those that have to be applied with a putty knife and cured by baking at 250° to 350° to bring to a hard mass. It is manufactured by Ren Plastics, Inc. and was obtained from representative Harry Stephenson, P.O. Box 7212, St. Louis, Missouri. The epoxy should be one that is filled by the addition of a foreign substance such as silica or aluminium, which gives body to the material and minimizes shrinkage during curing. Although a pint should be sufficient, the smallest amount usually available is a quart.

(A word of caution should be given about the hardener, or catalyst, used in many epoxies, which can cause a bad skin irritation if spilled on any exposed skin. Also, the fumes from the hardener can make one nauseated if inhaled and the mixing should always be done in a well ventilated room. With reasonable care to avoid spilling and inhaling, the average amateur should be able to handle this material without difficulty.)

After the epoxy hardened, the brass sleeves extending beyond the pipe fittings were trimmed off and the 12 set screws used to center the axles cut off and filed flush with the housing. A hole was drilled and tapped for a ¼-20 thread on each fitting, as shown in the close-up photo of the mounting, into which a knurled set screw was inserted to control tension on the two axles and lock them in position. To prevent scoring the shafts a piece of nylon or a similar material should be placed beneath the set screw and the metal.

Screw a 4" length of 1½" nipple into the opening of the "Y" and a flange fastened to the other end as a base. Another pipe flange is fastened to the bushing at the top end of the declination axle for securing the telescope saddle. Attach the polar axis shaft to the "T", insert both axles into their respective bearings and lock in place with collars.

Try the fit between the steel shafts and their bearings; in all probability they will be too tight. If so, partially withdraw them and put a small amount of valve grinding compound or similar abrasive on the shaft. Slide them back into the bearings and slowly rotate. Do this in easy steps, with frequent cleaning and checking. When satisfied, remove all traces of abrasive and coat the shaft with a light lubricant and replace in the bearing.

I recommend building your base stand so it can be topped with a pipe flange as shown in the photographs. Drill and tap four additional ¼-20 holes in the flat surface, locating them just inside the ones that

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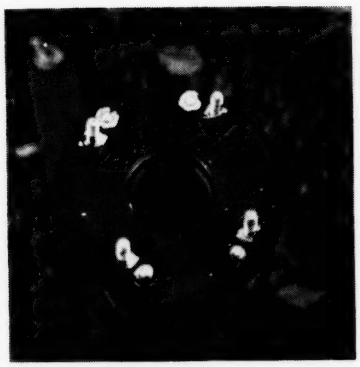

This photo shows detail of the lower flange which receives the base of the quatorial mounting. Long bolts receive similarly drilled upper flange; shorter bolts are for fine adjustment in aligning polar axis of mount with the celestial pole.

come in the unit. Four screws with lock nuts can be inserted from the bottom, while four other screws with regular nuts are secured to the flange. The base flange of the equatorial can be slipped over these latter screws and fastened down with wing nuts. I have found this a convenient place to "break" the mounting for portability and storage, and, with the system of adjusting and fastening

(Continued on page 34)

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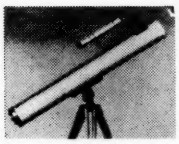

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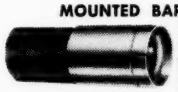

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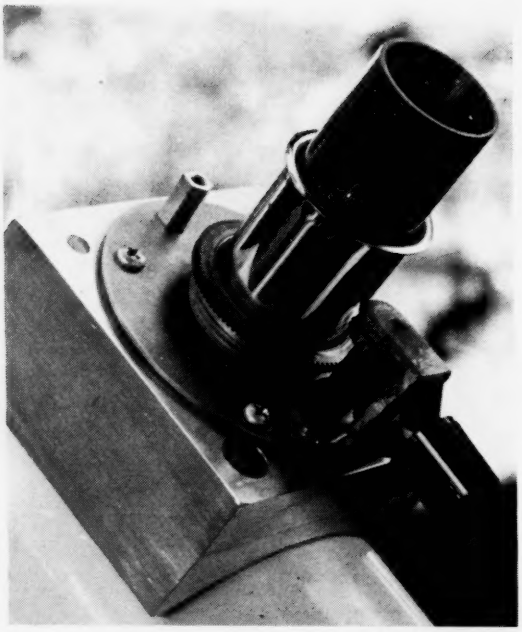

An added touch of sophistication to Mr. Ardery's instrument is this micrometric focusing device, combining helical and modified rack-and-pinion controls for fine adjustment. The unit is a surplus yoke assembly from a cathode ray tube.

(Continued from page 33)

screws, alignment on the pole is readily maintained.

The telescope weighs 45 pounds; the equatorial 35 pounds and the telescope 10 pounds; rugged yet quite portable.

If one were to use 2" pipe for the equatorial, then it would be possible to go to 1-5/16" steel shafting and cut pipe threads on the end that would screw directly into a standard 1" I.D. pipe adapter for mating with the larger pipe fittings. However, the larger pipe would require more epoxy and the unit would weight more when assembled. For the size instrument I was mounting the difference was not considered worth the change. For larger instruments the bigger pipe should be used, especially if a medium- or long-focus telescope is being placed on the mounting.

If one has difficulty soldering or does not have the equipment available it is possible to prevent the brass bearing sleeves from turning in the casting by using epoxy to fasten several lugs or vanes around the outside of the tubing before placing it in the pipe fittings.

With this instrument I have eagerly looked for and observed as many sky objects as possible in order to become familiar with the heavens. Having the advantage of quite a large and current private library being available to me I have also done considerable reading and studying. I should add that the "Through the Three-Inch" feature in R.P.A. has been very helpful to me.

James E. Ardery
2900 Rivermont Ave.
Lynchburg, Va.

(EDITOR'S NOTE: *In our many collective years spent in amateur astronomy this mounting by James E. Ardery represents one of the most practical and cleanest designs for a first mounting ever encountered.*

Experience dictates that the following comments on this mounting should be made:

The form of pipe "T" used is not a standard one in telescope making circles, and one can readily substitute the conventional form without affecting the operating performance of the mounting. Mr. Ardery's "T" does give a greater amount of overhang which, although it permits the tube to clear the pedestal, can be a serious source of vibration if the assembly is overloaded in the slightest.

The distance between the top of the pipe "T" and the telescope cradle is greater than generally recommended for stability, especially on long-focus telescopes, and this can be shortened considerably with an increase in rigidity and operating performance.

Although most satisfactory for a 4½-inch telescope, for larger size instruments at least 2" pipe fittings are recommended, unless the mirror is a rich-field type with a short focus.)

(Continued from page 3)

and faculae configurations in relation to the solar disk at 45 power. On May 20, my intentions being the same, I nearly didn't see this flare because of the lack of any great number of sunspots. However, I stayed, for I was fascinated by the excellent seeing (the first I have seen in four years of observing), which allowed me to see granules and faculae in great detail, the faculae sometimes being seen near the center of the sun's disk because of the excellent state of the air. I commenced drawing at 10:50 a.m. EDT (May 20th) and continued until 11:30 a.m.. when I took a break, returning at 11:45. A few minutes passed, when at 11:48 I spotted a very brilliant streak of light near the sun's limb directly opposite from where I was observing. The flare was actually bright enough for me to spot it out of the corner of my eye, using a solar filter—an amazing thing. My gaze, however, immediately became direct, my only other action being with the pencil to sketch in the flare's position, size, and shape on the almost completed drawing. The flare quickly died out, the whole sequence taking 2-5 seconds from start to finish. A copy of this drawing is enclosed.

Along with the flare, granules and faculae, I had the opportunity to see debris in our atmosphere twice traverse the solar disk, another interesting sight. All in all, it was a very busy observing session.

Edward Turco
2528 Cranston St.
Cranston 9, Rhode Island

We have checked with the Sacramento Peak Solar Observatory's weekly report of solar activity and there was an extremely low intensity flare recorded on May 20, but some two hours later than you indicated. This does not rule out your observation, of course, but it would have had to be an extremely bright flare to have been visible to the naked eye. We should like to hear from any readers who might have observed this phenomenon, either at that time or any time previously.

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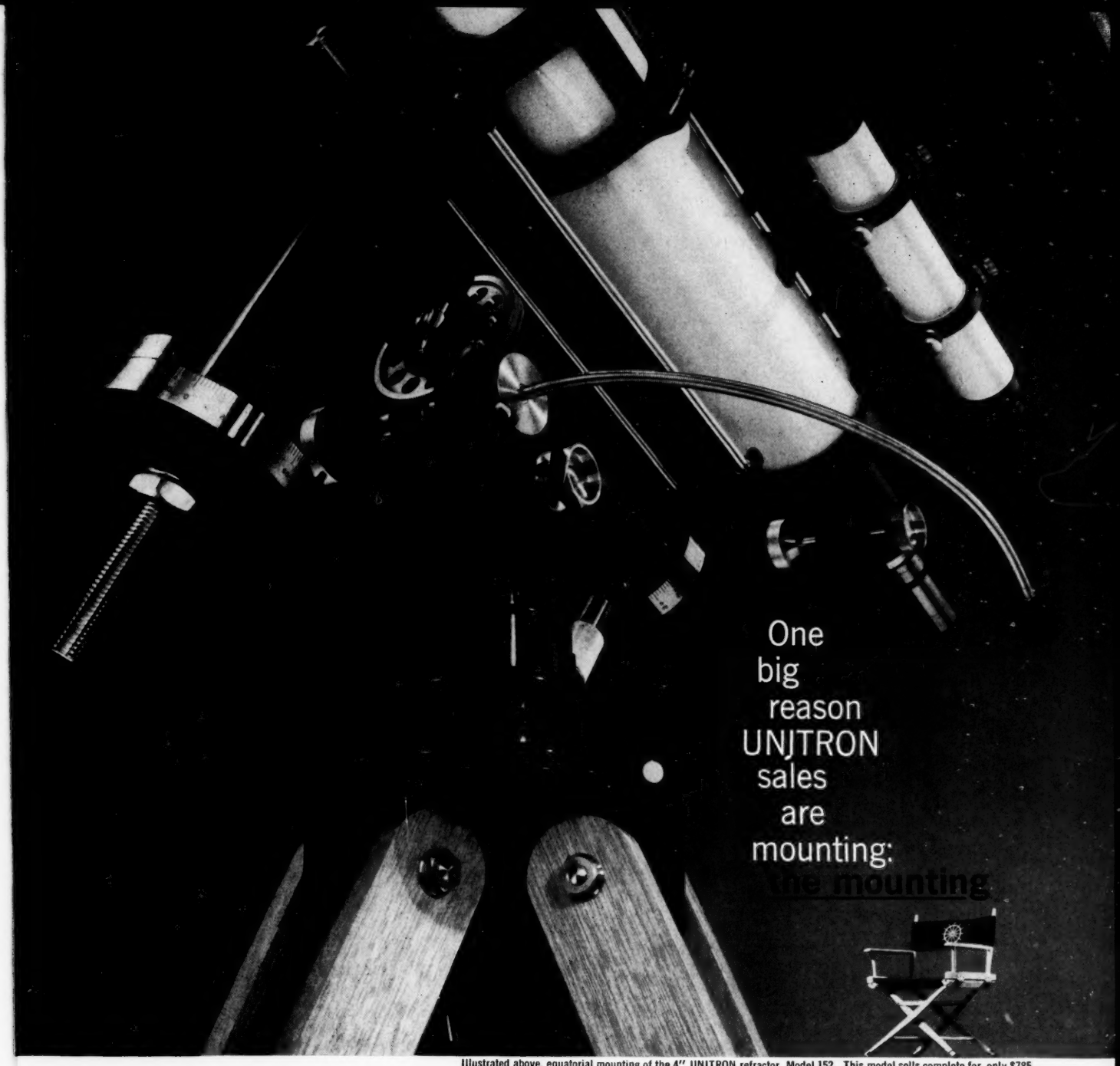

Illustrated above, equatorial mounting of the 4" UNITRON refractor, Model 152. This model sells complete for only $785.

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"Congratulations on the excellence of your workmanship. The optics are truly amazing. I never expected such wonderful performance."
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